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100 Areas CERCLA Ecological Investigations

Prepared for the U.S. Department of Energy
Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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100 Areas CERCLA Ecological Investigations

D. S. Landeen
M. R. Sackschewsky
S. Weiss

Date Published
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Richland, Washington 99352

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EXECUTIVE SUMMARY

This document reports the results of the field terrestrial ecological investigations conducted by Westinghouse Hanford Company during fiscal years 1991 and 1992 at operable units 100-FR-3, 100-HR-3, 100-NR-2, 100-KR-4, and 100-BC-5. The tasks reported here are part of the Remedial Investigations conducted in support of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 *studies for the 100 Areas. These ecological investigations provide (1) a description of the flora and fauna associated with the 100 Areas operable units, emphasizing potential pathways for contaminants and species that have been given special status under existing state and/or federal laws, and (2) an evaluation of existing concentrations of heavy metals and radionuclides in biota associated with the 100 Areas operable units.*

The 1991 and 1992 Westinghouse Hanford Company field investigations concentrated on the following: bird surveys, mammal and insect surveys, vegetation surveys, and biota sampling which included asparagus, reed canarygrass, trees, milfoil, raptor (birds of prey) pellets, coyote scat, and soil from ant mounds and small mammal burrow excavations.

Evidence of burrowing by small mammals and/or harvester ants was documented. Soil samples collected from small mammal burrows and ant mounds associated with these sites showed very low or undetectable levels of contaminants.

Concentrations of metals and radionuclides in coyote scat and raptor pellets were generally very low. Average lead concentrations in both coyotes and raptors were higher near the 100 Areas operable units than in samples

collected in control areas. Further studies would be needed to determine if these lead concentrations are correlated to roadside traffic, which has been documented elsewhere in the United States.

Vegetation samples (asparagus, reed canarygrass, tree leaves and limbs, and milfoil) were collected at several locations upriver and downriver of the operable units of interest. Results from these sampling efforts indicate little or no biological uptake of radionuclides or inorganic waste constituents, with the most notable exception of elevated strontium-90 concentrations (up to 88 pCi/g) in mulberry trees near the 100-BC and 100-K reactors.

The data presented in this report represent a substantial amount of information that can be used for comparative purposes in future sampling efforts at the Hanford Site. Also, this report provides details concerning the 100 Areas terrestrial ecology that can be used to support future remedial actions and clean-up measures.

The information presented in this report also includes previously published information contained in Landeen and Sackschewsky (1992), Fiscal Year 1991 100 Areas CERCLA Ecological Investigations.

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100 AREAS CERCLA ECOLOGICAL INVESTIGATIONS

1.0 INTRODUCTION

Work plans establishing the tasks for conducting the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Resource Conservation and Recovery Act of 1976* (RCRA) past-practice remedial investigations included ecological studies. For the 100 Areas, the ecological investigations are described identically in Appendix D-2 of each work plan for groundwater operable units (i.e., 100-FR-3, 100-HR-3, 100-NR-2, 100-KR-4 and 100-BC-5) (e.g, DOE-RL 1992a). Three habitat types are found in each of these operable units: aquatic (the Columbia River), riparian, and terrestrial. The relative uniformity of these operable units permitted coordination of the ecological tasks, maximizing cost effectiveness and data usability. The ecological tasks identified in the work plans include data compilation, a preliminary ecological investigations report, threatened and endangered species protection, field activities, laboratory analysis, and data evaluation.

This document reports the results of the field activities tasks, including (1) vegetation, insect, bird, and mammal surveys; and (2) vegetation, coyote scat, raptor pellet, and small mammal and harvester ant burrow soil sampling. Sample analysis generally included metals, strontium-90, and gamma spectroscopy.

The results of the fiscal year (FY) 1991 ecological field activities were reported in Sackschewsky and Landeen (1992); some but not all of the data in that report are duplicated here. Other documents related to the 100 Areas ecological investigations include the following:

- Cushing, C. E., 1993, *Aquatic Studies at the 100-HR-3 and 100-NR-1 Operable Units*, PNL-8584, Pacific Northwest Laboratory, Richland, Washington
- Fitzner, R. E., S. G. Weiss, and J. A. Stegen, 1992, *Biological Assessment for Threatened and Endangered Wildlife Species Related to CERCLA Characterization Activities*, WHC-EP-0513, Westinghouse Hanford Company, Richland, Washington
- Fitzner, R. E., and S. G. Weiss, 1992, *Bald Eagle Site Management Plan for the Hanford Site, South Central Washington*, WHC-EP-0510, Westinghouse Hanford Company, Richland, Washington
- Landeen, D. S., 1992, *Description of Work for 100 Areas Operable Unit Ecological Investigations*, WHC-SD-EN-AP-090, Westinghouse Hanford Company, Richland, Washington
- Sackschewsky, M. R., 1992, *Biological Assessment for Rare and Endangered Plant Species Related to CERCLA Characterization Activities*, WHC-EP-0526, Westinghouse Hanford Company, Richland, Washington

- Sackschewsky, M. R., D.S. Landeen, G. I. Baird, W. H. Rickard, and J. L. Downs, 1992, *Vascular Plants of the Hanford Site*, WHC-EP-0554, Westinghouse Hanford Company, Richland, Washington

- Stegen, J. A., 1992, *Biological Assessment for State Candidate and Monitor Wildlife Species Related to CERCLA*, WHC-SD-EN-EE-009 ENG, Westinghouse Hanford Company, Richland, Washington

- Weiss, S. G., and R. M. Mitchell, 1992, *A Synthesis of Ecological Data from the 100 Areas of the Hanford Site*, WHC-EP-0601, Westinghouse Hanford Company, Richland, Washington

- WHC, 1991a, *Ecological Data Compilation Investigations Status Report for 100 Areas Operable Units*, WHC-MR-0272, Westinghouse Hanford Company, Richland, Washington.

Other CERCLA ecological investigations also have been conducted on the Hanford Site. The most significant of these relative to the 100 Areas was completed for the 300-FF-5 and 300-FF-1 operable units (e.g., Brandt et al. 1993, Brandt and Rickard 1992, Rickard et al. 1990, Thiede 1992). These documents cover both Columbia River and terrestrial surveys and sampling at the 300 Area. Other studies, such as the long-term Hanford Sitewide and the near-facility monitoring programs, are continuing to collect data useful for the CERCLA investigation (see Schmidt et al. 1992 and Woodruff et al. 1992).

2.0 SCOPE OF WORK

2.1 OBJECTIVES

The objectives of the ecological field investigations included the following:

- To provide a description of the flora and fauna associated with the 100 Areas operable units with an emphasis on (1) potentially significant pathways, and (2) those species that have been classified as threatened, endangered, candidate, or monitor species by the state and/or federal governments

- To evaluate existing concentrations of contaminants in major species and pathways associated with the 100 Areas operable units.

The information regarding contaminant uptake by biota may help identify indicator species that can be monitored to assess the effectiveness of remedial actions. The information regarding special state- or federal-designated plant and wildlife species also contribute in determining Sitewide distributions of these species and present status in the 100 Areas.

2.2 FIELD INVESTIGATIONS

Field investigations have concentrated on bird surveys, mammal and insect surveys, vegetation surveys, and sampling of various biota for radionuclides and inorganic waste constituents analysis. These surveys were completed in accordance with Appendix D-2 of the groundwater operable unit work plans (e.g., DOE-RL 1992a). Attention has also been given to plant and wildlife species that have special classification status at state and/or federal levels. Table 1 lists and describes the various status codes for federal and state designations. The classifications of most concern are the federal and state threatened and endangered species. Table 2 contains the complete list of Hanford Site plants and animals that have special state or federal classification status and also indicates those species that were observed in the 100 Areas in 1991 and 1992. The Washington State classification codes in Table 1 were taken from the 1991 wildlife species lists (Washington Department of Wildlife June 19, 1991) and plant species lists (Washington Natural Heritage Program 1990). The federal species designations were obtained from the 50 CFR 17, which is updated several times each year. Both federal and state lists are revised frequently.

3.0 BIRD SURVEYS

3.1 BIRD SURVEYS

Three winter wildlife surveys were conducted (December 1990 and January and February 1991) at the 100-HR-3 and 100-BC-5 operable units. The main purposes were to help verify existing species lists (e.g., Landeen et al. 1992, Fitzner and Gray 1992) for the 100 Areas, to identify potentially significant pathways, and to verify and document the species of special concern that use the operable units, such as the American white pelican, bald eagle, and peregrine falcon.

All bird species observed during the surveys are listed in Table 3, in addition to those species observed at other times of the year. Some of the bird species commonly observed in the winter included Canada goose, horned lark, white-crowned sparrow, common raven, starling, great blue heron, and rock dove. Bald eagles and white pelicans were observed on all three surveys, but peregrine falcons were not observed. However, peregrine falcons have been documented to fly through the Hanford Site during migration and have been sighted flying along the Columbia River (Landeen et al. 1992). There were at least two peregrine falcon sightings at the Hanford Site in April 1992 and January 1993.

Spring, summer, and fall bird surveys also were conducted within the 100-HR-3 and 100-BC-5 operable units. Surveys were conducted within 1 hour of sunrise, in accordance with Westinghouse Hanford Company (Westinghouse Hanford) procedure EII 5.3 (WHC 1991b), on April 5; May 6, 24, and 29; and June 7, 11, and 27, 1991. Other bird surveys conducted at various times during the day occurred on March 4 and 8; April 16, 19, 22, 23, and 24; May 14, 22, and 24; June 27; and September 11 and 20, 1991. Bird species

observations also were recorded when other field work was being conducted throughout all seasons in 1991 and 1992. Surveys in the riparian zones along the Columbia River were conducted at all the reactors by walking within 50 m of the high-water mark along the river. Surveys also were conducted by walking and driving within the fenced areas at 100-B, -C, -H, -D, and -DR reactors. All bird species seen or heard on these occasions were recorded. No effort was made to quantify bird species inhabiting the operable units.

Table 3 also indicates those birds observed in breeding and nesting activities and those birds observed within the fenced areas at the 100 Areas reactors. Game birds observed include mourning doves, ring-necked pheasants, California quail, and gray partridge. The bird surveys, while not re-documenting the presence of all species on previous lists, did verify these lists in establishing that no potentially significant (in terms of contaminant pathways) "new" species were recorded.

3.2 POTENTIALLY SIGNIFICANT BIRD SPECIES

Table 3 includes birds that are both common on the Hanford Site (under status) and birds that were observed in the reactor areas. These birds generally represent five feeding types (depending on the season):

- Consumers of flying insects--common nighthawks, eastern and western kingbirds, flycatcher sp., swallow sp.
- Consumers of ground insects--killdeer, American robin
- Predators and/or scavengers--ring-billed gull, California gull, American kestrels, black-billed magpie, common raven, loggerhead shrike
- Seed-eaters--white-crowned sparrows, mourning and rock doves, quail, dark-eyed juncos, house finch
- Consumers of seeds and predominately surface insects--horned larks, western meadowlark, red-winged and Brewer's blackbirds, European starling, song sparrow, house sparrow.

In addition, common aquatic and riparian birds feed on shoreline vegetation and river biota. Those listed below are also common Hanford Site birds, seen during the surveys on and along the river. These may be broken into the following two general feeding groups:

- Consumers of aquatic insects and fish--bufflehead, common merganser, great blue heron, American white pelican, bald eagles
- Consumers of aquatic and terrestrial vegetation--Canada goose, mallard, American wigeon, northern shoveler, gadwall, redhead.

From this listing of commonly observed birds and their feeding habits, an evaluation of their significance relative to contaminant transport can be made (Section 5.0).

Table 1. Federal and State Status Codes for Special Plants and Animals. (sheet 1 of 2)

Code	Explanation
Federal (plants and animals)	
FE	Federal Endangered. A species in danger of extinction throughout all or a significant portion of its range.
FT	Federal Threatened. A species likely to become endangered in the foreseeable future.
FC_1	Candidate. Taxa for which enough substantive information is available to support listing as threatened or endangered by the federal government.
FC_2	Candidate. Taxa for which there is evidence of vulnerability, but not enough data to support listing proposals at this time.
FC_3	Candidate. Taxa that were once considered for listing as threatened or endangered, but are no longer candidates for listing.
FC_{3b}	Subcategory. Includes names that, on the basis of current taxonomic understanding, do not represent distinct taxa meeting the *Endangered Species Act of 1973* definition of "species."
State (wildlife)	
SE	Endangered. Species that are in danger of becoming extinct in the near future if factors contributing to their decline continue.
ST	Threatened. Species that are likely to become endangered in the near future if factors contributing to their population decline or habitat degradation continue.
SS	Sensitive. Species that are vulnerable or declining, and could become endangered or threatened without active management or removal of threats.
SC	Candidate. Wildlife species native to Washington State that the Department of Wildlife will review for possible listing as endangered, threatened, or sensitive.
SM	Monitored. Wildlife species native to Washington State that are of special interest because (1) they were at one time classified as endangered, threatened, or sensitive; (2) they require habitat that has limited availability during some portion of their life cycle; (3) they are indicators of environmental quality; (4) further field investigations are required to determine their population status; (5) there are unresolved taxonomic problems which may bear upon their status classification; (6) they may be competing with and impacting other species of concern; or (7) they have significant popular appeal.

Table 1. Federal and State Status Codes for Special Plants and Animals. (sheet 2 of 2)

Code	Explanation
	State (plants)
SE	Endangered. This status is assigned to each vascular plant taxon in danger of becoming extinct or extirpated in Washington State in the near future if factors contributing to its decline continue. Populations of these taxa are at critically low levels or their habitats have been degraded or depleted to a significant degree.
ST	Threatened. A threatened vascular plant taxon likely to become endangered in the near future in Washington State if factors contributing to its population decline or habitat degradation or loss continue.
SS	Sensitive. A vascular plant taxon is labelled sensitive when it is vulnerable or declining and could become endangered or threatened in Washington State without active management or removal of threats.
EX	Possibly extinct or extirpated in Washington State. Based on recent field searches, several plant taxa are considered to be possibly extinct or extirpated in Washington State. Taxa in this group are all high priorities for field investigation. If found, they will be assigned one of the above status categories.
SM_1	Monitor Group 1. Taxa for which there is insufficient data to support listing as threatened, endangered, or sensitive.
SM_2	Monitor Group 2. Taxa with unresolved taxonomic questions.
SM_3	Monitor Group 3. Taxa that are more abundant and/or less threatened than previously assumed.

Table 2. Federal and State Classifications of Wildlife and Plant Species at the Hanford Site. (sheet 1 of 6)

Wildlife											
Species		Federal					State				
Common name	Scientific name	E	T	C_1	C_2	C_3	E	T	S	C	M
peregrine falcon[b]	*Falco peregrinus*	X					X				
bald eagle[c]	*Haliaeetus leucocephalus*		X					X			
Aleutian Canada goose[b]	*Branta canadensis leucopareia*		X				X				
American white pelican[c]	*Pelecanus erythrorhynchos*						x				
sandhill crane[c]	*Grus canadensis*						x				
pygmy rabbit[b]	*Brachylagus idahoensis*				X			X			
ferruginous hawk[c]	*Buteo regalis*				X			X			
sage grouse	*Centrocercus urophasianus*				X					X	
Pacific western big-eared bat	*Plecotus townsendii*				X					X	
Columbia pebblesnail	*Fluminicola columbiana*				X					X	
loggerhead shrike[c]	*Lanius ludovicianus*				X					X	
black tern[c]	*Chlidonias niger*				X						X
Swainson's hawk[c]	*Buteo swainsoni*					X				X	
northern goshawk[b]	*Accipiter gentilis*				X					X	
common loon[c]	*Gavia immer*									X	
golden eagle[c]	*Aquila chrysaetos*									X	

Table 2. Federal and State Classifications of Wildlife and Plant Species at the Hanford Site. (sheet 2 of 6)

Wildlife											
Species		Federal					State				
Common name	Scientific name	E	T	C_1	C_2	C_3	E	T	S	C	M
flammulated owl[b]	*Otus flammeolus*									X	
burrowing owl	*Athene cunicularia*									x	
sage thrasher	*Oreoscoptes montanus*									X	
sage sparrow[c]	*Amphispiza belli*									X	
shortfaced lanx	*Fisherola nuttalli*									X	
Merriam's shrew	*Sorex merriami*									X	
striped whipsnake	*Masticophis taeniatus*									X	
trumpeter swan[b]	*Cygnus buccinator*				X						
Lewis' woodpecker[b]	*Melanerpes lewis*									X	
western bluebird[b]	*Sialia mexicana*									X	
mountain sucker	*Catostomus platyrhynchus*										X
sand roller	*Percopsis transmontana*										X
piute sculpin	*Cottus beldingi*										X
reticulate sculpin	*Cottus perplexus*										X
Woodhouse's toad[c]	*Bufo woodhousei*										X
night snake	*Hypsiglena torquata*										X
horned grebe[c]	*Podiceps auritus*										X

Table 2. Federal and State Classifications of Wildlife and Plant Species at the Hanford Site. (sheet 3 of 6)

Wildlife											
Species		Federal					State				
Common name	Scientific name	E	T	C_1	C_2	C_3	E	T	S	C	M
western grebe[c]	*Aechmophorus occidentalis*										X
Clark's grebe	*Aechmophorus clarkii*										X
great blue heron[c]	*Ardea herodias*										X
great egret[c]	*Casmerodius albus*										X
black-crowned night-heron[c]	*Nycticorax nycticorax*										X
turkey vulture[b]	*Cathartes aura*										X
osprey[c]	*Pandion haliaetus*										X
merlin	*Falco columbarius*										X
gyrfalcon[b]	*Falco rusticolus*										X
prairie falcon[c]	*Falco mexicanus*										X
black-necked stilt[b,c]	*Himantopus mexicanus*										X
long-billed curlew[c]	*Numenius americanus*					X					X
caspian tern[c]	*Sterna caspia*										X
arctic tern[b]	*Sterna paradisaea*										X
Forster's tern[c]	*Sterna forsteri*										X
snowy owl	*Nyctea scandiaca*										X

Table 2. Federal and State Classifications of Wildlife and Plant Species at the Hanford Site. (sheet 4 of 6)

Wildlife											
Species		Federal					State				
Common name	Scientific name	E	T	C_1	C_2	C_3	E	T	S	C	M
barred owl[b]	*Strix varia*										X
ash-throated flycatcher	*Myiarchus cinerascens*										X
grasshopper sparrow	*Ammodramus savannarum*										X
lesser goldfinch[b]	*Carduelis psaltria*										X
pallid bat	*Antrozous pallidus*										X
northern grasshopper mouse	*Onychomys leucogaster*										X
sagebrush vole	*Lagurus curtatus*										X

Table 2. Federal and State Classifications of Wildlife and Plant Species at the Hanford Site. (sheet 5 of 6)

Plants											
Species		Federal					State				
Common name	Scientific name	E	T	C_1	C_2	C_3	E	T	S	C	M
northern wormwood	*Artemisia campestris* ssp. borealis var. wormskioldii			X				X			
Columbia yellowcress	*Rorippa columbiae*				X			X			
Columbia milkvetch	*Astragalus columbianus*				X				X		
Hoover's desertparsley	*Lomatium tuberosum*				X				X		
Thompson's sandwort[c]	*Arenaria franklinii* var. thompsonii						X				
dense sedge	*Carex densa*									X	
bristly cryptantha	*Cryptantha interrupta*									X	
gray cryptantha[c]	*Cryptantha leucophaea*									X	
shining flatsedge	*Cyperus rivularis*									X	
Piper's daisy	*Erigeron piperianus*									X	
southern mudwort	*Limosella acaulis*									X	

Table 2. Federal and State Classifications of Wildlife and Plant Species at the Hanford Site. (sheet 6 of 6)

Plants											
Species		Federal					State				
Common name	Scientific name	E	T	C_1	C_2	C_3	E	T	S	C	M
false pimpernel	*Lindernia anagallidea*									X	
dwarf desert primrose	*Oenothera pygmaea*									X	
desert dodder	*Cuscuta denticulata*										X
Robinson's onion	*Allium robinsonii*										X
squill onion	*Allium scillioides*										X
Columbia River mugwort	*Artemisia lindleyana*										X
stalked-pod milkvetch[c]	*Astragalus sclerocarpus*										X
medick milkvetch	*Astragalus speirocarpus*										X
crouching milkvetch[c]	*Astragalus succumbens*										X
rosy balsamroot	*Balsamorhiza rosea*										X
Palouse thistle	*Cirsium brevifolium*										X
smooth cliffbrake	*Pellaea glabella*										X
fuzzy beardtongue	*Penstemon eriantherus*										X

[a]Refer to Table 1 for an explanation of federal and state status codes.
[b]Species that are considered very rare or observed only once or twice.
E = Endangered.
T = Threatened.
C = Candidate.
M = Monitored.
[c]Species observed during 1991 and 1992 at 100 Areas operable units.

Table 3. Birds Observed at 100 Areas Operable Units.
(sheet 1 of 4)

Family	Common name	Genus species	Status
Gaviidae	common loon	*Gavia immer*	Rw
Podicipedidae	pied-billed grebe[a]	*Podilymbus podiceps*	Cr
	horned grebe	*Podiceps auritus*	Uw
	western grebe	*Aechmophorus occidentalis*	Ur
Pelecanidae	American white pelican	*Erythrorhynchos pelecanus*	Cr
Phalacrocoracidae	double-crested cormorant	*Phalacrocorax auritus*	Rr
Ardeidae	great blue heron[a]	*Ardea herodias*	Cr
	black-crowned night-heron	*Nycticorax nycticorax*	Cr
	great egret	*Casmerodius albus*	Rm
Anatidae	Canada goose[a]	*Branta canadensis*	Cr
	tundra swan	*Cygnus columbianus*	Rw
	mallard	*Anas platyrhynchos*	Cr
	northern pintail	*Anas acuta*	Cw
	blue-winged teal	*Anas discors*	Us
	cinnamon teal	*Anas cyanoptera*	Us
	northern shoveler	*Anas clypeata*	Cw
	gadwall	*Anas strepera*	Cw
	American wigeon	*Anas americana*	Cw
	redhead	*Aythya americana*	Cw
	ring-necked duck	*Aythya collaris*	Uw
	lesser scaup	*Aythya affinis*	Uw
	greater scaup	*Aythya marila*	Rw
	common goldeneye	*Bucephala clangula*	Uw
	bufflehead	*Bucephala albeola*	Cw
	common merganser	*Mergus merganser*	Cw
	ruddy duck	*Oxyura jamaicensis*	Uw
Accipitridae	osprey	*Pandion haliaeetus*	Um
	bald eagle	*Haliaeetus leucocephalus*	Cw
	northern harrier[a]	*Circus cyaneus*	Cr
	Swainson's hawk[b]	*Buteo swainsoni*	Us
	red-tailed hawk	*Buteo jamaicensis*	Cr
	ferruginous hawk[b]	*Buteo regalis*	Rs
	rough-legged hawk	*Buteo lagopus*	Rw
	golden eagle	*Aquila chrysaetos*	Ur
Falconidae	American kestrel[a,b]	*Falco sparverius*	Cr
	merlin	*Falco columbarius*	Rr
	prairie falcon	*Falco mexicanus*	Ur

Table 3. Birds Observed at 100 Areas Operable Units.
(sheet 2 of 4)

Family	Common name	Genus species	Status
Phasianidae	gray partridge	*Perdix perdix*	Ur
	chukar	*Alectoris chukar*	Ur
	ring-necked pheasant[a]	*Phasianus colchicus*	Ur
	California quail[a]	*Callipepla californica*	Ur
Rallidae	American coot[a]	*Fulica americana*	Cr
Gruidae	sandhill crane	*Grus canadensis*	Um
Charadriidae	killdeer[a,b]	*Charadrius vociferus*	Cr
Scolopacidae	greater yellowlegs	*Tringa melanoleuca*	Um
	long-billed curlew	*Numenius americanus*	Cs
	common snipe	*Gallinago gallinago*	Ur
Laridae	ring-billed gull[b]	*Larus delawarensis*	Cr
	California gull[b]	*Larus californicus*	Cr
	caspian tern	*Sterna caspia*	Us
	Forster's tern	*Sterna forsteri*	Cs
	black tern	*Chlidonias niger*	Rm
Columbidae	rock dove[a,b]	*Columba livia*	Cr
	mourning dove[a,b]	*Zenaida macroura*	Cr
Tytonidae	common barn-owl[b]	*Tyto alba*	Ur
Strigidae	great horned owl	*Bubo virginianus*	Ur
	long-eared owl[a]	*Asio otus*	Ur
Caprimulgidae	common nighthawk[b]	*Chordeiles minor*	Cs
Trochilidae	calliope hummingbird	*Stellula calliope*	Um
Alcedinidae	belted kingfisher	*Ceryle alcyon*	Ur
Picidae	northern flicker	*Colaptes auratus*	Cr
Tyrannidae	western wood-pewee	*Contopus sordidulus*	Um
	willow flycatcher	*Empidonax traillii*	Rm
	Say's phoebe[b]	*Sayornis saya*	Us
	western kingbird[a,b]	*Tyrannus verticalis*	Cs
	eastern kingbird[a]	*Tyrannus tyrannus*	Us
Alaudidae	horned lark[a,b]	*Eremophila alpestris*	Cr
Hirundinidae	northern rough-winged swallow[b]	*Stelgidopteryx serripennis*	Us
	bank swallow	*Riparia riparia*	Us
	cliff swallow[a,b]	*Hirundo pyrrhonota*	Cs
	barn swallow[a,b]	*Hirundo rustica*	Cs

Table 3. Birds Observed at 100 Areas Operable Units.
(sheet 3 of 4)

Family	Common name	Genus species	Status
Corvidae	black-billed magpie[a,b]	*Pica pica*	Cr
	common raven[a,b]	*Corvus corax*	Cr
	Clark's nutcracker	*Nucifraga columbiana*	Am
Paridae	black-capped[b] chickadee	*Parus atricapillus*	Ur
Troglodytidae	marsh wren[a]	*Cistothorus palustris*	Ur
Muscicapidae	ruby-crowned kinglet	*Regulus calendula*	Uw
	American robin[a,b]	*Turdus migratorius*	Cr
	varied thrush	*Ixoreus naevius*	Uw
Bombycillidae	cedar waxwing	*Bombycilla cedrorum*	Ur
Laniidae	northern shrike	*Lanius excubitor*	Uw
	loggerhead shrike[a,b]	*Lanius ludovicianus*	Us
Sturnidae	European starling[a,b]	*Sturnus vulgaris*	Cr
Vireonidae	solitary vireo	*Vireo solitarius*	Um
	warbling vireo	*Vireo gilvus*	Um
Emberizidae	yellow warbler	*Dendroica petechia*	Us
	yellow-rumped warbler	*Dendroica coronata*	Cw
	Townsend's warbler	*Dendroica townsendi*	Um
	Wilson's warbler	*Wilsonia pusilla*	Um
	western tanager	*Piranga ludoviciana*	Um
	black-headed grosbeak	*Pheucticus melanocephalus*	Us
	vesper sparrow	*Pooecetes gramineus*	Rm
	lark sparrow	*Chondestes grammacus*	Rs
	sage sparrow	*Amphispiza belli*	Us
	savannah sparrow[a,b]	*Passerculus sandwichensis*	Us
	song sparrow[b]	*Melospiza melodia*	Cr
	white-crowned sparrow[b]	*Zonotrichia leucophrys*	Cr
	dark-eyed junco[b]	*Junco hyemalis*	Cw
	red-winged blackbird[a,b]	*Agelaius phoeniceus*	Cr
	western meadowlark[a,b]	*Sturnella neglecta*	Cr
	yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Cs
	Brewer's blackbird[a,b]	*Euphagus cyanocephalus*	Cr
	brown-headed cowbird	*Molothrus ater*	Cr
	northern oriole	*Icterus galbula*	Cs

Table 3. Birds Observed at 100 Areas Operable Units.
(sheet 4 of 4)

Family	Common name	Genus species	Status
Fringillidae	house finch[b] American goldfinch	*Carpodacus mexicanus* *Carduelis tristis*	Cr Ur
Passeridae	house sparrow[b]	*Passer domesticus*	Cr

A status rating is given for abundance and seasonal occurrence for each species as follows:

Abundance:
C = common; often seen or heard in appropriate habitat.
U = uncommon; usually present but not always seen or heard.
R = rare; present in appropriate habitats only in small numbers, seldom seen or heard.
A = accidental; appeared once or twice, but well out of normal range.

Seasonal occurrence:
r = resident; present all year but abundance may vary seasonally.
s = summer visitor (includes spring and fall).
w = winter visitor (includes spring and fall).
m = migrant.
[p] that were observed in breeding and nesting activities.
[b]Species observed within the fenced areas surrounding the 100 Areas reactors.

4.0 INSECT AND MAMMAL SURVEYS

All mammal species observed during field work activities (such as vegetation surveys, bird surveys, sampling, and general site reconnaissance at the operable units) were recorded. No effort was made to quantify mammals inhabiting these sites or to inventory bat species that might be present. Trapping was not conducted to determine the presence or absence of small mammal species. Harvester ant colonies were recorded at individual waste sites and burial grounds associated with the reactors.

4.1 MAMMALS

All mammals observed inhabiting the operable units were recorded. Signs of animal activity such as burrowing, tracks, and scat were accepted as evidence that the animal was inhabiting or using a given area. For instance, badgers were never sighted, but ample evidence of burrowing activity in several areas indicated that badgers do inhabit or forage for prey throughout the 100 Areas. Mammals observed on several occasions included coyotes, mule deer, blacktail jackrabbits, and porcupines. Burrowing evidence of small mammals such as the Great Basin pocket mouse and northern pocket gopher was also common. Table 4 lists all the mammals observed during the study. Table 4 also indicates those mammals known to inhabit the 100 Areas but not actually observed during the course of the study (Rickard et al. 1974).

Of these mammals, the mule deer, coyote, Great Basin pocket mouse, jackrabbit and cottontail rabbit are the most common and most likely to be significant pathways for contaminants. The following dietary information is taken from Greager (1981).

Mule deer depend heavily on the riparian vegetation during the hot, dry summer months when other plants have dried. These deer eat willows, Russian thistle, goldenrod, and other plants but tend to avoid gray rabbitbrush and cheatgrass.

Jackrabbits consume predominately yarrow, turpentine cymopterus, Jim Hill mustard, buckwheat, and rabbitbrush; cottontail rabbits feed on seasonally available herbs and shrubs.

Coyotes are omnivorous, eating whatever may be most plentiful and easiest to catch, such as rabbits, pocket mice, grasshoppers, darkling beetles, birds, deer, reptiles, fruit, and grasses.

The single most important food item of pocket mice is cheatgrass seeds, with insects and spiders preferred in spring before seeds ripen.

4.2 MAMMAL AND INSECT SURVEYS AT INDIVIDUAL WASTE SITES

As previously mentioned, insect and mammal surveys were conducted at individual waste sites (trenches, cribs, burial grounds, etc.) associated with the reactors as identified in Stone (1989). Burrowing activity by small mammals was observed and recorded, as was the presence of harvester ant

mounds. Harvester ants excavate materials and bring them to the surface from as far as 15 to 20 ft deep and have been implicated in bringing up contamination from some of the burial grounds in the 200 East Area (Conklin et al. 1985). At the Hanford Site, ants are probably the insects that are most likely to bring up any significant amounts of contaminated material.

The majority of the trenches, cribs, and burial grounds in these operable units have been covered with large amounts of cobble and treated with nonselective herbicides for several years; so, few of the waste sites have flora or fauna inhabiting them. When vegetation is encountered, tumbleweed is predominant at these sites. Results of the surveys taken at these waste sites are provided in Table 5.

5.0 WILDLIFE SURVEY CONCLUSIONS

The wildlife species that were observed in the 100 Areas verified previous published lists even though all species known to inhabit the 100 Areas were not actually observed. No new species were documented that would be of significance in an ecological assessment.

Intrusive activities, such as well drilling, that are conducted inside the controlled-area fences at the operable units will not have any significant negative impact on wildlife. Well drilling and cleanup/remedial activities that are conducted outside the fences will have minimal impact on wildlife if the recommendations contained in the three documents described below are followed. These documents are the *Bald Eagle Management Plan* (Fitzner and Weiss 1992), the *Biological Assessment of Threatened and Endangered Species* (Fitzner et al. 1992), and the *Biological Assessment for State Candidate and Monitor Species* (Stegen 1992). DOE and WHC policy also states that site-specific ecological surveys will be conducted at all sites where cleanup and remedial actions are performed. These site-specific surveys also provide recommendations that can mitigate impacts to wildlife.

While this report is not intended to be an ecological risk assessment, a preliminary, qualitative, evaluation of the significance of the potential wildlife pathways is provided. This information may be useful for future sampling efforts, risk assessors, and risk managers.

The consumers of flying insects indicated in Section 3.1 are not expected to consume significant contamination in their prey, because the consumers and their prey are both highly mobile. In addition, current and previous work by Cushing (1993 and Cushing et al. 1981) indicates no measurable contamination in aquatic insect larvae, which presumably would have a higher body burden than the flying adults. However, mud-nest building behavior in swallows may be a transport pathway if the swallows use contaminated mud for nest construction. No evidence of this was seen in the 100 Areas.

Members of the other groups listed previously have greater potential for significant uptake of contaminants. However, the results of near-field

Table 4. List of All the Mammals Observed and Known To Inhabit the 100 Areas Operable Units.

Common name	Scientific name
badger	*Taxidea taxus*
coyote	*Canis latrans*
Great Basin pocket mouse	*Perognathus parvus*
northern pocket gopher	*Thomomys talpoides*
beaver	*Castor canadensis*
blacktail jackrabbit	*Lepus californicus*
bushytail woodrat	*Neotoma cinerea*
mountain cottontail	*Sylvilagus nuttalli*
mule deer	*Odocoileus hemionus*
porcupine	*Erethizon dorsatum*
muskrat	*Ondatra zibethica*
Mammals known to inhabit areas near the Columbia River but not observed	
vagrant shrew	*Sorex vagrans*
pallid bat	*Antrozus pallidus*
little brown myotis	*Myotis lucifugus*
yuma myotis	*Myotis yumanensis*
townsend ground squirrel	*Spermophilus townsendii*
western harvest mouse	*Reithrodontomys megalotis*
deer mouse	*Peromyscus maniculatus*
sagebrush vole	*Lagurus curtatus*
montane meadow mouse	*Microtus montanus*
Norway rat	*Rattus norvegicus*
house mouse	*Mus musculus*
racoon	*Procyon lotor*
mink	*Mustela vison*
longtail weasel	*Mustela frenata*
shorttail weasel	*Mustela erminea*
otter	*Lutra canadensis*
striped skunk	*Mephitis mephitis*
bobcat	*Lynx rufus*

Table 5. Insect and Mammal Surveys at 100 Areas Operable Units.
(sheet 1 of 3)

Reactor site	Waste site	Comments
BC	116-B-1 (trench)	All cobble, some tumbleweeds
BC	116-B-5 (crib)	Chain-link fence, big tumbleweeds, deer tracks, pocket mouse activity
BC	116-B-7 (outfall structure)	Partial chain-link fence, lots of tumbleweeds
BC	116-B-8 (outfall structure)	Three ant mounds (2 large), deer tracks, pocket mouse activity, cheatgrass, tumbleweeds, and rabbitbrush
BC	116-B-11 (retention basin)	Chain-link fence, all cobble, a few tumbleweeds
BC	116-C-5 (retention basin)	Two tanks, all cobble
BC	118-B-2 (burial ground)	All cobble and tumbleweeds
D	116-DR-1 (trench)	Cobble and tumbleweeds
D	116-DR-5 (outfall structure)	Some rabbitbrush, three ant mounds, rabbit sign
D	116-D-3 (french drain)	Cobble and tumbleweeds
D	116-D-4 (french drain)	Cobble and tumbleweeds
D	116-D-5 (outfall structure)	Some rabbitbrush, rabbit sign
D	116-D-7 (retention basin)	Chain-link fence, cobble and tumbleweeds
D	116-D-1A (trench)	Cobble and tumbleweeds
D	116-D-1B (trench)	Cobble and tumbleweeds
D	118-D-1 (burial ground)	All cobble, no vegetation
D	118-D-2 (burial ground)	Cobble and tumbleweeds
D	118-D-3 (burial ground)	Cobble and tumbleweeds
D	120-D-1 (ponds)	Some rabbitbrush, rabbit sign, 3 small ant mounds
D	128-D-1 (burn pit)	Tumbleweeds, not sprayed with herbicide, old garbage, concrete foundation, pocket mice, deer tracks

Table 5. Insect and Mammal Surveys at 100 Areas Operable Units.
(sheet 2 of 3)

Reactor site	Waste site	Comments
H	118-H-1 (burial ground)	Cobble and lots of tumbleweeds
H	118-H-2 (burial ground)	Cobble and tumbleweeds
H	118-H-3 (burial ground)	Cobble and tumbleweeds
H	118-H-4 (burial ground)	Cobble and tumbleweeds
H	118-H-5 (burial ground)	Cobble and tumbleweeds
H	116-H-1 (trench)	Cobble and tumbleweeds
H	116-H-2 (trench)	Some berm, tumbleweeds
H	116-H-7 (retention basin)	Chain-link fence, cobble, and tumbleweeds
H	126-H-1 (ash pit)	Lots of small tumbleweeds, lots of coal slag, some pocket mice, few ants on perimeter
H	128-H-1 (burning pit)	Lots of small tumbleweeds, rabbitbrush, deer tracks, pocket mice
H	1607-H-2 (tile field)	Cheatgrass, pepper grass, geese foraging area, one old badger hole
K	118-K-1 (burial ground)	Heavily cobbled, no vegetation present, some burrowing activity on perimeter
K	116-K-1 (Crib)	Cobbled, some tumbleweeds, burrowing activity on perimeter
K	Inert Waste Landfill	Lots of cheatgrass and small tumbleweeds, some debris, some burrowing activity
K	116-K-2 (Trench)	Cobbled, no vegetation
N	1312-N-LERF	Standing water at times in rubber bladder, some rabbitbrush, russian thistle and cheatgrass on edges
N	116-N-3 (Crib)	Covered with concrete and cobbled, Burrowing activity on perimeter
N	116-N-2 (Tank)	Not cobbled, lots of rabbitbrush, russian thistle and cheatgrass, ant and burrowing activity

Table 5. Insect and Mammal Surveys at 100 Areas Operable Units.
(sheet 3 of 3)

Reactor site	Waste site	Comments
N	116-N-1 (Crib)	Dominated by rabbitbrush, Russian thistle and cheatgrass, varying topography, ants and burrows present
F	126-F-1 (Ash Pit)	Not cobbled, lots of tumble mustard russian thistle and cheatgrass, some rabbitbrush, berms present, ant and burrowing activity
F	116-F-14 (retention basin)	Cobbled, no vegetation, some ant activity on perimeter
F	116-F-1 (Trench)	Cobbled, no vegetation, some ant activity on perimeter
F	116-F-2 (Trench)	Cobbled, very little vegetation
F		Surface Contamination Site, some grasses, cryptogams, some burrowing activity
F	116-F-9 (Trench)	Cobbled, no vegetation
F	118-F-5 (Burial Ground)	Cobbled, no vegetation
F	Surface contamination Area	PNL Rad Waste Burial Site, lots of tumble mustard, cheatgrass, and Russian thistle, some ant and burrowing activity
F	118-F-2 (Burial Ground)	Cobbled, some ant and burrowing activity on perimeter
F	118-F-4 (Burial Ground)	Cobbled, some tumbleweeds and cheatgrass
F	118-F-1, F-6 (Burial Ground)	Cobbled, no vegetation

vegetation sampling (see Tables H-10 - H-17 in Appendix H) indicate extremely low levels of contaminants in vegetation from within the reactor areas, and burrow soil results (Tables G-1 - G-6 in Appendix G) show no evidence of small mammals or ants excavating contaminants from waste sites, which could then have been a pathway for several of the bird feeding groups. The results of raptor pellets and coyote scat sampling (Tables E-1 - E-2 in Appendix E) show limited pathway movement of contaminants in the 100 Areas. Previously, however, small mammals have been shown to bring contamination to the surface of waste sites, and rock doves, closely associated with buildings in the 100 and 200 Areas, have been shown to contain contamination (Conklin et al. 1982), (Conklin et al. 1983).

Mammals (deer, pocket mice, rabbits) also may be in pathways from eating either contaminated vegetation or contaminated prey, such as birds or mice. Woodruff et al. (1993) and the sampling reported in this document (coyote scat and mammal burrows) indicate only localized and low contamination in mammals, such as rabbits from the 100-N Area (with 88 pCi/g strontium-90 in bones, Woodruff et al. 1992).

The aquatic birds are also not expected to be significant pathways. Yearly aquatic biota sampling (e.g., Woodruff et al. 1992) and Cushing (1993) indicate slight to undetectable contamination in the 100 Areas prey of many of the aquatic birds listed: periphyton, caddisfly larvae, clams, bass, whitefish, and salmon. Extensive vegetation sampling results reported in this document also show only rare and low "hits" of contamination in riparian trees, asparagus, and reed canarygrass.

6.0 PLANT COMMUNITY ANALYSES

Plant communities near the Columbia River within the 100 Areas aggregate units were surveyed during 1991 and 1992. The surveys consisted of searches for rare and endangered plant species, qualitative community delineations, the compilation of species lists within the different community types, and the identification and mapping of plants on or near the river shore that have a potential for a direct food-chain link to humans or to higher trophic levels within the ecosystem. Appendix I provides a list of all plant species observed at all the operable units.

6.1 PLANT COMMUNITY DELINEATIONS

The plant communities within the 100 Areas operable units immediately adjacent to the Columbia River have been broadly described as riparian and as a cheatgrass community in areas away from the shoreline (Rogers and Rickard 1977). This classification is broadly correct, but finer delineations are possible. The community delineations described in the following paragraphs were made by field reconnaissance and are strictly qualitative in nature. The delineations were made by visually determining the dominant plant species or vegetation types and were based on the species most apparent at the time of inspection. In most cases, a particular area was visited at least twice (at different parts of the growing season). For the purposes of this

report, the community delineations or descriptions are provided to suggest dominant species or associations of species that occur within different physiognomic, edaphic, or topographic units.

Quantitative measurements of species frequency, abundance, or coverage may result in slightly different classifications. Most of the surveys described in the following sections are concerned with the thin riparian strip of vegetation and cover the region from the shoreline of the Columbia River to approximately 400 m inland. The community changes that can occur over the relatively narrow riparian zone of the Columbia River are described in Fickeisen et al. (1980) and Brandt et al. (1993). Beyond this distance from the shore, much of the rest of the area within the 100 Areas operable units consists of old agricultural fields dominated by cheatgrass and tumblemustard, with scattered abandoned orchards and a few remnant pockets of big sagebrush and gray rabbitbrush.

The shoreline communities within the 100 Areas operable units were divided into sections to ease the description process; a map of these sections is provided in Appendix I. These divisions are not meant to represent separate, distinct communities; each division comprises several distinct vegetation associations. Species lists for these areas are provided in Appendix I. While an attempt was made to identify all of the species located in each area, some were missed undoubtedly because of very low populations, or because the species were not in an identifiable state at the time of the surveys. All species identifications were made following Hitchcock and Chronquist (1973).

The vegetation within most of the exclusion areas around the reactors and on the cribs and burial grounds is very sparse or non-existent. Those plant species that are present are primarily weedy plants such as Russian thistle, Jim Hill mustard, cheatgrass, a few assorted herbs and some gray rabbitbrush. Plants such as Russian thistle and Rabbitbrush are deep rooted and have the potential to uptake radionuclides and other contaminants and, therefore, could be part of a pathway of contaminants to other parts of the ecosystem. Some of the radiological control zones, such as those near 100-K and 100-N Areas consist of essentially native vegetation and many of the plant species present could contribute to contaminant transport throughout the ecosystem.

6.1.1 100-BC Area

The region upstream from the 100-BC Area is dominated by a thick stand of willow, with interspersed patches of reed canarygrass, sedges, thickspike wheatgrass, and goldenrod. Much of the area is classified as wetland. The wetland area is home to at least three state sensitive species (*Limosella acaulis*, *Lindernia anagallidea*, and *Cyperus rivularis*). Downstream from the 100-BC Area is a cobble shoreline with relatively sparse vegetation. Many white mulberries, elms, and junipers are present, with an understory of scattered tumblemustard and cheatgrass.

The plant community bounded by the 100-BC Area fence almost entirely comprises the alien species of tumblemustard, Russian thistle, and cheatgrass. Modest stands of gray rabbitbrush are present as well as a few scattered bunchgrasses (mostly sand dropseed).

The section extending from the 100-BC Area to the Allard Pumphouse is primarily typified by relatively steep slopes extending from the dry, cheatgrass-dominated uplands to the river shore, with a fairly narrow riparian zone. The shoreline itself is steep, with many large cobbles and boulders. The vegetation is primarily reed canarygrass, *Poa*, sedges, and tickseed.

6.1.2 100-K Area

The section of shoreline between the Allard Pumphouse and 100-K Area is one of the most diverse vegetative communities in the 100 Areas. There are many trees in this area, primarily Mulberries, Elms, and Willows, with nearly 100 other species present. Physically, the area is defined by a peninsula that juts upriver at Coyote Rapids. This forms a backwater area that functions as an isolated pond during times of low water. The standing-water-saturated ground, boulder-strewn peninsula, and the typical sandy/silty riparian shores provide a vast array of different substrates and habitat types within a relatively small geographic area.

The area bounded by the 100-K Area fence, like many of the other reactor areas, is essentially devoid of plant life except for scattered cheatgrass, Russian thistle, and an occasional rabbitbrush.

The stretch of river shore between 100-K and 100-N Areas is characterized by a gently sloping shoreline with a relatively broad riparian zone. The trees (primarily elm and mulberry) are distributed primarily in isolated clumps of five or six individuals. The vegetative community is diverse, showing several distinct vegetative zones. Near the water line, the community is strongly dominated by reed canarygrass, beyond this is a *Poa pratensis* zone, an *Agropyron dasytachyum* zone, and finally the dryland cheatgrass/ Sandberg's bluegrass community. Each of the vegetation zones has a large number of associated species, a complete listing of the species observed within the riparian zone between 100-K and 100-N is provided in Appendix I. The shoreline itself consists of areas of large boulders and areas of gently sloping mudflats where healthy populations of *Limosella acaulis* can be found.

Beyond the riparian zone between 100-K and 100-N is a dryland, cheatgrass-dominated community that perhaps typifies much of the 100 Areas. The area has been disturbed in the past, probably by fire, and is now primarily cheatgrass with approximately 25 associated native and introduced species.

6.1.3 100-N Area

Because the 100-N Area is still relatively active, there is very little vegetation present within the 100-N Area proper. To the south and east of the 100-N Area is the approximately 600-acre Knob-and-Kettle topography (Rickard et al. 1974) or giant ripple marks (Reidel et al. 1992). Most of this area has been burned and is now almost completely dominated by cheatgrass and Sandberg's bluegrass.

The shoreline between 100-N and 100-D Areas is extremely steep with a narrow riparian community clinging to the bottom of the slope. The community is primarily dominated by reed canarygrass.

6.1.4 100-D Area

Like the 100-BC, -K and -N Areas, the sparse community bounded by the 100-D Area fences is almost entirely composed of cheatgrass, Russian thistle, and tumblemustard. Few native species are present in this highly disturbed community.

The most obvious feature of the shoreline immediately adjacent to the 100-D Area is a large stand of mature elm trees consisting of approximately 100 individuals. This stand occurs on a sand/cobble bench above the normal high-water mark. There is little or no understory component beneath much of this stand. Surrounding the stand of trees is a short-statured dryland community that includes a number of species but is dominated primarily by cheatgrass, sand dropseed, and tumblemustard. At least 40 species are present on this shelf, including white mulberry, reed canarygrass, and 2 species of lupine. Downstream from the elm-dominated bench is a riparian community dominated by reed canarygrass and bentgrass with a number of white mulberries.

East of 100-D Area is a sandy, open community with a dominate shrub component of sagebrush and rabbitbrush. The understory consists of the native perennial bunchgrasses, indian ricegrass, squirreltail bottlebrush and needle-and-thread grass, along with two species of milkvetch and prickly-pear cactus.

6.1.5 Riparian Communities in the 100-HR-3 Operable Unit

At the northeast corner of 100-D Area is a mixed community dominated in sections by big sagebrush with an understory of cheatgrass and tumblemustard. There are two abandoned apricot orchards and a considerable amount of old-field vegetation in this area. Other readily apparent species include Munro's globemallow, yellow bee-plant, and gray rabbitbrush. The majority of the dryland areas within the 100-HR-3 operable unit are abandoned agricultural fields with a few abandoned orchards. There are very few isolated pockets of native vegetation, cheatgrass is the most abundant species, with various alien annuals, globemallows and, along roadway edges, sand dropseed and needle-and-thread grass.

The shoreline to the northeast of 100-D Area transitions from the higher ground of the reactor area through a low-lying zone of undulating topography, to a broad, flat, rocky plain. Several community types can be discerned over this topographic gradient.

The region in the vicinity of river kilometer 605.8, about 1 km north of 100-D Area, is characterized by undulating topography and coarse sands. Many of the topographic depressions become saturated for varying periods of time. These swales are dominated by sedges, with smaller populations of rushes and clover-fern. Between the swales, the community is dominated by thickspike wheatgrass, bluegrass, and Russian thistle. A distinct community dominated by wooly mullein and cocklebur is at the northern edge of this zone. The shoreline itself is heavily dominated by reed canarygrass. The area around river mile 376.25 is characterized by a relatively flat, cobble plain, with a large sand hill, approximately 3 m tall and 100 m long, located about 500 m from the shoreline. The sandhill itself is dominated by wheatgrass, with several individuals of giant wildrye. East of the sandhill the community is dominated by Russian thistle, cheatgrass, tumblemustard, with little else

present. The plain to the west of the sandhill is characterized by pockets of sedges, wheatgrass, cheatgrass, and tumblemustard. The Columbia tickseed is evident during the summer. The plain appears to be part of an old riverbed and appears to be moist if not inundated at times of peak river flow.

The river bends sharply to the east at approximately river mile 375.75, with a backwater inlet formed after the river bends. This creates, at least during high water, a stubby peninsula that points north at the bend in the river (see Figure I-1, Appendix I). Several distinct communities can be delineated on this peninsula. On the western half is an area consisting almost exclusively of diffuse knapweed. Downriver from the knapweed community the surface is dominated by wheatgrass, and off the southern end of the inlet is an area dominated by red three-awn. An area between all three of these communities is dominated by cheatgrass and Russian thistle. Several sand mounds are located on the east side of the wheatgrass community at the tip of the peninsula. These mounds are dominated by giant wildrye and slimleaf goosefoot, with a lesser component of lupine (two different species). The shoreline is dominated by reed canarygrass and bluegrass, with several small, isolated elms and white mulberries.

Continuing west from the peninsula, the shoreline gradually changes from a gentle rocky plain, with a broad riparian habitat, to a steep, distinct drop-off with a narrow riparian zone. The soil substrate gradually changes from large cobbles at the south end of the backwash to gravelly sand farther east. The edges of the backwash area are dominated by wetland species and the inlet usually has standing water until midsummer. A patch of inundated willows dominates the mouth of the backwash, and little vegetation is present in the rest of the area having standing water. The dryland communities to the east side of the backwash are dominated by cheatgrass with subdominant components of sand dropseed at the western end with Columbia daggerpod and Gray's desertparsley becoming common farther to the east.

The shoreline is a wetter, periodically saturated area with large components of horsetail, sedges, bluegrass, and yellow sweet clover. This river stretch culminates with two stands of mature trees (primarily black locust) between river miles 373.75 and 373.0. The community between and underneath the stands of trees is best described as weedy, primarily cheatgrass, flixweed, and tumblemustard. A few giant wildrye individuals are present between the stands of trees. The shoreline in this area is steep but relatively sandy and is dominated by reed canarygrass and bluegrass, with numerous white mulberries and several golden currant bushes.

6.1.6 100-H Area

The shoreline adjacent to 100-H area is steeply sloped, with a narrow riparian zone dominated by reed canarygrass and bluegrass, and several white mulberries and golden currants. The shoreline flattens out to the south of 100-H Area in the vicinity of H-slough.

There are no fences remaining around the 100-H Area, but most of the area that was included in the exclusion zone is highly disturbed, with many burial grounds, cribs, and old building sites visible. Much of the area is dominated by gray rabbitbrush and cheatgrass. The roadways are lined with sand dropseed and Russian thistle.

6.1.7 100-F Area

The section of shoreline between the 100-H and 100-F Areas from H-slough through the White Bluffs Townsite was not specifically examined nor characterized for this report because it is outside the boundaries of any of the 100 Areas operable units. However, several distinct communities can be discerned from passive observation. The area referred to as the Whitebluffs or H-slough is a broad wetland formed in the shallows between the main shoreline and an area of high ground that is an island during times of peak riverflow. Above the shoreline in this area is a community dominated by very large sagebrush and giant wildrye. The Whitebluffs Ferry Site is south of the sagebrush/wildrye community. The Ferry site is dominated by a large collection of mature trees, primarily cottonwood and black locust. The understory is very weedy, with much of the ground surface completely covered with Russian knapweed.

The area included within the former boundaries of 100-F Area is primarily dominated by gray rabbitbrush and cheatgrass. Sand dropseed can be found along the roadways. There are also numerous, although scattered, remnant trees, including sycamores, mulberries, junipers, elms, and poplars.

The shoreline adjacent to the 100-F Area is very steep, with a narrow riparian zone. Much of the shoreline consists of large cobbles and boulders. At the southern end of the boundaries of the 100-F Area the shoreline abruptly flattens into a rocky plain that eventually graduates into the backwater, wetland area known as F-slough. The rocky plain has conspicuous populations of lupine and Gray's desertparsley.

6.2 THREATENED AND ENDANGERED PLANT SPECIES

There are 12 plant species known to be on or near the Hanford Site that are listed by the Washington State Natural Heritage Program (1990) as endangered, threatened, or sensitive (Sackschewsky 1992). These species are listed in Table 6. The two state endangered and the two state threatened species on this list are also listed as candidates for federal protection under the *Endangered Species Act of 1973*. Special emphasis was placed on the search for all 12 species while conducting the community delineation and species inventory field work. An assessment of the impacts of characterization activities on threatened, endangered, and sensitive plant species is available in Sackschewsky (1992).

The persistent sepal or Columbia yellowcress is found along the Hanford Reach from the Vernita bridge to the 300 Area (Sauer and Leder 1985). During the FY 1991 and 1992 field surveys, the species was located in the vicinity of 100-B Area, adjacent to the Allard pumphouse (about 3 km north of 100-D Area) and at the Hanford Townsite. Previously the persistent sepal yellowcress has been found near 100-D Area, White Bluffs, and on many of the Columbia River islands.

The southern mudwort and the false pimpernel also were located in the wetland area just west of the 100-B Area. The southern mudwort also was found on mudflats east of 100-K Area. Both of these species are likely to be found at other wetland areas along the Hanford Reach of the Columbia River.

Table 6. Hanford Site Endangered, Threatened, and Sensitive Plant Species.[a]

Scientific name	Common name	Family	Washington State status
Rorippa columbiae[b] Suksd. ex Howell	persistent sepal yellowcress	Brassicaceae	Endangered
Artemisia campestris L ssp. *borealis* (Pall.) Hall & Clem. var. *wormskioldii*[b] (Bess.) Cronq.	northern wormwood	Asteraceae	Endangered
Astragalus columbianus[b] Barneby	Columbia milk-vetch	Fabaceae	Threatened
Lomatium tuberosum[b] Hoover	Hoover's desert-parsley	Apiaceae	Threatened
Cryptantha interrupta (Greene)Pays.	bristly cryptantha	Boraginaceae	Sensitive
Cryptantha leucophaea Dougl. Pays	gray cryptantha	Boraginaceae	Sensitive
Erigeron piperianus Cronq.	Piper's daisy	Asteraceae	Sensitive
Carex densa L.H. Bailey	dense sedge	Cyperaceae	Sensitive
Cyperus rivularis Kunth	shining flatsedge	Cyperaceae	Sensitive
Oenothera pygmaea	dwarf evening primrose	Onagraceae	Sensitive
Limosella acaulis Ses.& Moc.	southern mudwort	Scrophulariaceae	Sensitive
Lindernia anagallidea (Michx.)Pennell	false pimpernel	Scrophulariaceae	Sensitive

[a]All of these species have been reported on or near the Hanford Site.
[b]Indicates candidates on the 1990 Federal Register, Notice of Review.

The shining flatsedge and the dense sedge (*Carex densa*) have been reported from the 100-BC wetland (Washington Natural Heritage Program [WNHP] Database). The shining flatsedge has not been subsequently relocated at that or any other location on the Hanford Site; however, it has been reported from the Priest Rapids area (Mastrogiusseppe and Gill 1983).

Specimens resembling the dense sedge were collected at the 100-BC wetland and numerous other sites within the 100 Areas during the FY 1992 field surveys. These were subsequently identified as Fox sedge (*Carex vulpinoidea*) (Appendix K). These two sedge species share several characteristics in common and can easily be confused if mature material is not available. Dense sedge is primarily a California species, with Washington State at the extreme northern periphery of its distribution. The site of the Hanford Site population that was reported to WNHP was resampled during 1992 and was identified as *C. vulpinoidea*; therefore, it is unlikely that *C. densa* inhabits the Hanford Site, especially because it is otherwise known only from Clark and Wahkiakum counties in southwestern Washington, and *C. vulpinoidea* has been reported previously at Priest Rapids (Mastrogiusseppe and Gill 1983). However, until the specimen that the original WNHP report was based is relocated and examined, the potential for finding *C. densa* on the Hanford Site cannot be ignored.

The gray cryptantha was observed in the dunes area to the east of the 100-D Area. This species is usually found among sand dunes, especially those south of the Hanford Townsite.

None of the other threatened, endangered, or sensitive plant species were observed in the 100 Areas during FY 1991. The bristly cryptantha and the dwarf evening primrose exist in Franklin County directly across the river from the 300 Area. The dwarf evening primrose is also known to exist just north of the Wye barricade. Piper's daisy occurs on Umtanum Ridge on the western edge of the Hanford Site and was found during FY 1991 in the vicinity of B-Pond near the 200 East Area. Piper's daisy has been reported near 100-H reactor (Sackschewsky et al. 1992) but has not subsequently been relocated in that area. The Columbia milkvetch is found on the Yakima Firing Range and has been found on Umtanum Ridge at the western edge of the Hanford Site and at Priest Rapids. The bristly cryptantha, dwarf evening primrose, Piper's daisy, and the Columbia milkvetch could inhabit certain communities in the 100 Areas. Hoover's desertparsley inhabits steep talus slopes near Priest Rapids Dam at the western edge of the Hanford Site. Hoover's desertparsley is not expected to be found in the 100 Areas.

The northern wormwood is one of the rarest plant taxa in Washington State. Northern wormwood is known from only two populations, both near the Columbia River. One population is near The Dalles, Oregon, and the other is located near Beverly, Washington, approximately 16 km northeast of the Vernita Bridge. Many plant communities along the Columbia River on the Hanford Site resemble those near Beverly, Washington. Because of the proximity of one of the known populations to the Hanford Site, the similarity of habitat, and the extreme rarity of the taxa, special emphasis has been placed on locating any populations of northern wormwood that may occur on the Hanford Site. Currently, no populations of the northern wormwood (*Artemisia campestris wormskioldii*) have been found on the Hanford Site; however, another variety of the same species (*Artemisia campestris scouleriana*) is very common on the

Hanford Site and occurs sympatrically with the population of var. *wormskioldii* near Beverly, Washington. The *scouleriana* variety is not a special-status taxa.

6.3 OTHER SPECIES OF INTEREST

Several plant groups are of interest in the course of these investigations because of the possibilities for contaminant transport to higher trophic levels within the ecosystem and for short or direct pathways of radionuclides to humans. The three plant groups monitored during FY 1991 were reed canarygrass, asparagus, and trees. The methods and results of direct vegetation sampling for radionuclides are provided in Section 7.0 of this report.

If radionuclides are taken up by plants, the radionuclides could eventually reach the human population. This may result from direct consumption of contaminated plants by humans, or indirectly through human consumption of animals that have eaten the contaminated vegetation. Direct pathways to humans are possible through plants such as asparagus and mulberries. Indirect pathways can result from human consumption of deer or rabbits that have consumed contaminated asparagus, from deer that have consumed mulberries, or geese that have consumed reed canarygrass.

Besides asparagus and mulberries, there are well over 100 additional species on the Hanford Site that can be considered edible (Sackschewsky et al. 1992). Table 7 provides a listing of a few of the important edible species known to inhabit the 100 Areas of the Hanford Site. Some of these plants may not be obvious consumables to all readers, but they have been used as food sources by other cultures. The most desired foods are asparagus and the fruits from the abandoned apple, pear, peach, and apricot orchards along the Columbia River as well as various berries. Most of the other species would only be sought by experienced natural-food enthusiasts. Soldat et al. (1990) have considered wild edible plants in evaluating potential radiation doses to people harvesting plants and wildlife in the 100 Areas.

The basic distributions of trees, asparagus, and reed canarygrass were determined in the 100 Areas. Reed canarygrass is extremely common all along the shore of the Columbia River. At many locations reed canarygrass can be considered the dominant species of shoreline vegetation. Asparagus is also widely distributed. It is normally represented by widely scattered clumps; it rarely constitutes a dominant component of any community. Abandoned asparagus fields are still readily discernable at the Hanford townsite.

Trees along the shoreline within the 100 Areas were mapped individually. The most prevalent species is white mulberry, with two major stands of black locust and one major stand of Siberian elms (below 100-D Area). Elms also occur scattered along the shore at many locations. Other species observed include golden currants, apricots, junipers, and willows. Upstream from the 100-B Area the most common tree is the willow, with a few scattered elms and white mulberries. Shoreline maps showing the location and identity of all trees in the 100 Areas are archived in field logbook #WHC-N-534.

Table 7. Hanford Site Edible Plants.

Scientific name	Common name	Plant parts used
Amaranthus spp.	amaranth, pigweed	leaves, seeds
Balsamorhiza careyana	balsamroot	whole plant
Galium aparine	cleavers	shoots, seeds
Lomatium spp.	biscuitroot	roots, seeds
Rubus spp.	blackberry, raspberry	fruits
Scirpus spp.	bulrush	roots, shoots, pollen, seeds
Typha spp.	cattail	pollen, roots
Cichorium intybus	chicory	leaves, roots
Prunus spp.	cherries, peaches, etc.	fruit
Pyrus spp.	pear, apple	fruit
Rosa woodsii	Wood's rose	rosehips, flowers
Taraxacum officinale[a]	dandelion	leaves, roots, flowers
Rumex spp.	dock, sorrel	leaves
Oenothera spp.	evening primrose	young roots
Ribes spp.	gooseberry, currant	fruit
Juniperus scopulorum	juniper	"berries"
Chenopodium album	lamb's quarters	leaves, young stems
Calochortus macrocarpus	sagebrush mariposa lily	bulbs
Montia perfoliata	miner's lettuce	leaves
Mentha spp.	mint	leaves
Allium spp.	onion	bulbs
Lepidium spp.	pepperweed	fruits, seeds
Capsella bursa-pastoris	shepherd's purse	leaves, seeds
Plantago spp.	plantain	leaves
Opuntia spp.	prickly pear	fruits, stems
Portulaca oleracea	common purslane	leaves, stems
Tragopogon dubius	salsify, goatsbeard	roots
Asclepias speciosa	showy milkweed	flowers, shoots
Veronica spp.	brooklime	leaves, stems
Helianthus annuus	common sunflower	seeds
Cirsium spp.	thistle	peeled stems, roots
Vicia cracca	bird vetch	fruits
Asparagus officinalis	asparagus	young shoots
Lactuca serriola	prickly lettuce	young leaves
Morus alba	white mulberry	fruit
Juglans nigra	black walnut	nuts
Salix spp.	willow	bark, leaves
Rorippa nasturtium-aquatica	watercress	leaves
Apocynum sibericum	indian hemp	bark
Achillea millefolium	yarrow	leaves

spp. = species, more than one.

7.0 BIOTA SAMPLING

Biota and soil samples were collected at several sites associated with the operable units. Media that was collected included asparagus, reed canarygrass, water milfoil, tree leaves and limbs, raptor pellets, coyote scat, and soil samples from ant mounds and small mammal burrows. Samples were collected following the methodologies given in the Description of Work for this project (Landeen 1992). All samples were sent to an offsite laboratory (TMA-NORCAL) for radionuclide and inorganic constituents analysis. Maps showing sample locations of all media collected are presented in Appendix A. Details of these sampling efforts are given in the following sections.

7.1 ASPARAGUS

Asparagus (*Asparagus officinalis*) was collected during April 1991 and May 1992 at the sites depicted in Figure A-1 of Appendix A. A duplicate sample was collected during both collecting periods. Control samples were collected above Vernita Bridge and at Horn Rapids on the Yakima River. The samples were analyzed for total gamma radiation, strontium-90, technetium-99, and total TAL metals.

7.2 REED CANARYGRASS

Reed canarygrass (*Phalaris arundinacea*) was collected during July 1991 and 1992 at the sites depicted in Figure A-2 of Appendix A. Three to six samples of reed canarygrass were collected at each sampling location. Duplicate samples were collected both years and control samples were collected upriver of the Vernita Bridge next to the Columbia River. All of the samples were analyzed for the same constituents as the asparagus.

7.3 TREE LEAVES AND LIMBS

Mulberry (*Morus alba*) leaves and limbs were collected during July 1991 and July and October 1992 at the sites indicated in Figure A-3 of Appendix A. Two samples of tree leaves were collected at every sampling location. Duplicate samples were collected both years and control samples were collected above Vernita Bridge next to the Columbia River. All of the samples were analyzed for the same constituents as the asparagus. Some of the tree leaves were also analyzed for tritium.

7.4 WATER MILFOIL

At the request of the U.S. Environmental Protection Agency, three water milfoil (*Myriophyllum spicatum*) samples were collected at N Springs on October 7, 1992, and one control sample was collected above Vernita Bridge in the Columbia River (Figure A-3). The samples were analyzed for TAL metals, strontium-90, and total gamma radiation.

7.5 ANIMALS (COYOTES AND RAPTORS)

Raptor pellets and coyote scat were collected near some of the reactor areas in the 100 Areas (Figure A-4). Raptors are generally defined as birds of prey, which include hawks, eagles, and owls. Control samples were collected on the north side of the Columbia River on the Wahluke slope. The samples were analyzed for TAL metals, strontium-90, and total gamma radiation.

7.6 ANT MOUNDS AND SMALL MAMMAL BURROWS

Soil samples from active harvester ant (*Pogonomyrmex owyheei*) mounds and small mammal burrows were collected adjacent to waste sites at each of the reactors in the 100 Areas (Table 8). Harvester ants form their mounds by excavating and bringing soil and rock particles to the surface. Harvester ants sometimes excavate materials from as far as 5 m down (Porter and Jorgensen 1988) and, thus, can serve as indicators of environmental quality. Previous work in the 300 Area (Fitzner et al. 1979) has shown the abundance of harvester ants on disturbed soil such as wastes sites and their potential for deep excavation of contaminants.

Small mammals also form mounds from excavated material brought to the surface and serve as indicators of contaminant uptake (Landeen and Mitchell 1981 and 1982). Burrows sampled were made by the Great Basin pocket mouse (*Perognathus parvus*), which is the most abundant small mammal at the Hanford Site. Pocket mice are prolific burrowers and excavate burrow systems usually 0.6 to 1.2 m in depth, but might burrow deeper (Landeen and Mitchell 1981).

The samples were sent to an offsite laboratory and analyzed for TAL metals, strontium-90, and cesium-137.

8.0 DATA ANALYSIS

Results of all the analytical data collected are presented in Appendixes B through H. Information regarding sample identification numbers, sample locations, and associated data validation qualifiers are presented also. The data presented below is compared with offsite control samples collected as part of this study and other similar efforts (Table 9). The data are also compared with the average values from all media collected as part of this study (Table 10) as well as other sampling efforts previously conducted at the Hanford Site. These previous sampling efforts include sediment sampling associated with springs adjacent to the Columbia River throughout the 100 Areas (Table 11) and the 2101-M Pond characterization study on the 200 Area plateau (DOE-RL 1993) (Table 12). Data are also compared with soil threshold values, which were calculated in Ritzville silt loam at the Hanford Site (Table 13) (Wildung et al. 1986) and other soil threshold values and maximum values reported in DOE-RL (1993) from the Hanford Site (Table 14). The soil threshold values presented in Tables 13 and 14 indicate differences

Table 8. Ant Mound and Burrow Sampling Locations.

Reactor	Sample #	Sample media	Waste site ID	Description
BC	B078Z0	ant	118-B-1	Burial Ground
BC	B078Z1	burrow	118-B-1	Burial Ground
BC	B078Z2	burrow	118-B-1	Burial Ground
BC	B078Z3	burrow	118-B-1	Burial Ground
BC	B078Z4	ant	118-C-4	Burial Ground
BC	B078Z5	ant	118-C-4	Burial Ground
BC	B078Z6	ant	118-C-1	Burial Ground
BC	B078Z7	ant	118-C-1	Burial Ground
BC	B078Z8	burrow	116-C-5	Retention Basin
K	B078Z9	burrow	118-K-1	Burial Ground
K	B07900	burrow	118-K-1	Burial Ground
K	B07901	burrow	118-K-1	Burial Ground
K	B07902	burrow	116-K-1	Crib
K	B07903	burrow	116-K-1	Crib
K	B07904	burrow	116-K-1	Crib
K	B07905	burrow	116-K-1	Crib
N	B07937	burrow	116-N-2	Storage Tank
N	B07906	burrow	116-N-3	Crib
N	B07907	burrow	116-N-1	Crib
N	B07908	ant	116-N-1	Crib
N	B07909	ant	116-N-1	Crib
N	B07910	ant	116-N-1	Crib
N	B07911	ant	116-N-1	Crib
N	B07912	burrow	116-N-1	Crib
D	B06NC2	ant	116-DR-9	Retention Basin
D	B06NC3	burrow	116-DR-9	Retention Basin
D	B06NC4	ant	116-DR-9	Retention Basin
D	B06NC5	burrow	116-D-3	French Drain
D	B06NC6	ant	116-D-4	French Drain
D	B06NC7	burrow	116-D-1	Burial Ground
D	B06NC8	ant	116-D-2	Burial Ground
D	B06NC9	burrow	116-D-2	Burial Ground
F	B06N95	ant	126-F-1	Ash Pit, Sur. Cont.
F	B06N96	burrow	126-F-1	Ash Pit, Sur. Cont.
F	B06N97	burrow	126-F-1	Ash Pit, Sur. Cont.
F	B06N98	ant	126-F-1	Ash Pit, Sur. Cont.
F	B06N99	burrow		
F	B06NB0	ant	116-F-14	Liquid Disposal
F	B06NB1	burrow	116-F-1	Trench
F	B06NB2	ant	116-F-2	Burial Ground
F	B06NB3	burrow	116-F-2	Burial Ground
H	B06NB4	ant	118-H-3	Burial Ground
H	B06NB5	ant	118-H-3	Burial Ground
H	B06NB6	burrow	118-H-3	Burial Ground
H	B06NB7	burrow	118-H-3	Burial Ground
H	B06NB8	ant	116-H-7	Retention Basin
H	B06NB9	ant	116-H-7	Retention Basin
H	B06NC0	burrow	116-H-7	Retention Basin
	B06NC1	ant	118-H-2	Burial Ground

Table 9. Average Values of all Control Samples Collected in 1991 and 1992 as Part of 100 Areas Ecological Investigations and Other Studies. (sheet 1 of 2)

Constituent	Sample Media and Total Number of Samples				
	3 RAPTORS	4 COYOTE	1 MILFOIL	4 2101-M SOIL	3 TREES
Aluminum	1920.00	3005.00	987.00	7775.00	1097.67
Antimony	3.53	3.43	19.60	--	5.33
Arsenic	3.13	2.93	3.80	--	1.20
Barium	49.00	61.63	114.00	88.25	123.50
Beryllium	0.14	0.08	0.63	--	0.26
Cadmium	0.21	0.20	5.50	--	0.81
Calcium	94066.67	57350.00	26200.00	4300.00	86166.67
Chromium	4.27	4.68	7.00	8.50	4.37
Cobalt	1.76	3.00	3.10	9.25	1.65
Copper	17.37	15.93	26.00	11.75	22.10
Iron	4016.67	6700.00	1780.00	23250.00	1503.67
Lead	2.63	3.18	9.80	6.25	3.73
Magnesium	3256.67	4010.00	2650.00	4325.00	19176.67
Manganese	90.63	138.50	370.00	367.50	85.90
Mercury	0.00	0.00	0.47	--	0.98
Nickel	3.17	4.15	9.00	9.50	3.23
Potassium	1427.00	2987.75	2570.00	1450.00	41900.00
Selenium	3.93	3.83	4.60	--	3.43
Silver	0.52	0.51	2.90	--	1.73
Sodium	1524.67	2319.00	1190.00	165.00	609.00
Thallium	0.45	0.26	4.50	--	1.07
Vanadium	7.93	12.93	5.40	62.25	3.21
Zinc	214.87	141.40	206.00	42.75	126.13
Cyanide	NR	NR	NR	NR	NR

NOTE: All metals are reported in mg/kg.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table 9. Average Values of all Control Samples Collected in 1991 and 1992 as Part of 100 Areas Ecological Investigations and Other Studies. (sheet 2 of 2)

Constituent	Sample Media and Total Number of Samples			
	1 BURROW	8 GRASS	5 ASPARAGUS	1 ANTS
Aluminum	7630.00	767.67	26.08	4560.00
Antimony	3.20	5.49	7.83	3.10
Arsenic	3.00	1.53	1.59	2.30
Barium	105.00	24.26	5.80	68.30
Beryllium	0.13	0.16	0.61	0.13
Cadmium	0.19	0.47	0.90	0.18
Calcium	11700.00	3854.17	2052.50	8180.00
Chromium	10.90	2.88	3.28	5.50
Cobalt	10.40	0.90	1.48	10.10
Copper	11.60	8.65	8.58	12.60
Iron	20900.00	1336.75	53.58	19800.00
Lead	13.50	2.04	0.97	5.50
Magnesium	4810.00	2196.67	1137.50	4020.00
Manganese	388.00	70.63	12.98	269.00
Mercury	0.05	0.17	0.54	0.05
Nickel	9.70	2.72	3.38	6.50
Potassium	1870.00	14928.33	26775.00	990.00
Selenium	0.77	1.79	3.27	0.68
Silver	0.87	1.01	1.93	0.81
Sodium	208.00	175.49	171.50	198.00
Thallium	0.75	0.44	0.91	0.66
Vanadium	52.10	2.60	1.33	52.20
Zinc	115.00	76.43	59.28	43.30
Cyanide	NR	NR	NR	NR

NOTE: All metals are reported in mg/kg.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table 10. Average Values of all Samples Collected in 1991 and 1992 as Part of 100 Areas Ecological Investigations and Other Studies. (sheet 1 of 2)

Constituent	Sample Media and Total Number of Samples					
	4	7	3	28	30	27
	RAPTORS	COYOTE	MILFOIL	SEDIMENTS	2101-M SOIL	TREES
Aluminum	946.00	1505.00	4453.33	6361.00	7360.00	294.70
Antimony	3.65	3.53	6.60	9.32	0.00	6.06
Arsenic	3.35	3.09	4.40	--	0.23	1.45
Barium	53.85	45.39	124.33	69.60	75.50	113.90
Beryllium	0.15	0.17	0.38	0.31	0.26	0.29
Cadmium	0.33	1.04	4.50	0.96	0.30	0.69
Calcium	115950.00	94157.14	21100.00	3987.30	3463.33	77618.52
Chromium	3.70	4.66	9.93	35.96	10.35	2.79
Cobalt	0.80	1.40	3.43	7.44	9.77	1.52
Copper	13.25	15.34	40.57	19.03	516.20	23.33
Iron	2147.50	3824.29	7596.67	32602.70	20526.67	490.76
Lead	5.98	7.83	19.20	--	8.60	1.90
Magnesium	3082.50	4431.43	4353.33	3689.10	3733.00	13112.96
Manganese	157.70	135.00	787.67	316.00	271.80	111.48
Mercury	0.00	0.00	0.29	--	--	1.00
Nickel	1.70	2.94	10.63	12.40	9.70	3.62
Potassium	1427.50	3045.29	4483.33	800.50	1086.70	60892.59
Selenium	4.15	3.94	1.57	--	--	3.31
Silver	0.54	0.52	0.99	1.15	3.50	1.70
Sodium	2973.25	2004.00	1758.00	190.00	94.00	385.52
Thallium	0.69	0.50	1.50	--	1.70	1.39
Vanadium	4.73	6.84	13.73	38.20	51.10	1.44
Zinc	349.75	259.64	246.00	174.12	127.60	120.71
Cyanide	NR	NR	NR	NR	NR	NR

NOTE: All metals are reported in mg/kg.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table 10. Average Values of all Samples Collected in 1991 and 1992 as Part of 100 Areas Ecological Investigations and Other Studies. (sheet 2 of 2)

Constituent	Sample Identification Numbers			
	27	72	17	22
	BURROW	GRASS	ASPARAGUS	ANTS
Aluminum	7360.74	248.69	27.91	5689.09
Antimony	3.26	4.24	6.25	3.22
Arsenic	2.02	0.81	2.44	1.80
Barium	210.12	22.28	4.01	110.18
Beryllium	0.49	0.18	0.49	0.40
Cadmium	0.19	0.32	1.05	0.19
Calcium	6080.74	4226.76	1435.00	5229.55
Chromium	8.34	1.67	2.72	7.01
Cobalt	8.86	0.74	1.25	8.54
Copper	14.53	6.53	8.16	14.03
Iron	17170.37	449.42	71.11	16890.91
Lead	6.50	1.30	0.82	7.30
Magnesium	4431.48	2092.69	1031.29	3868.64
Manganese	291.93	52.53	10.32	263.45
Mercury	0.05	0.09	0.23	0.05
Nickel	9.80	1.53	2.81	8.08
Potassium	1638.11	15709.88	22370.59	1396.64
Selenium	1.03	1.40	2.17	0.70
Silver	0.76	0.75	1.60	0.68
Sodium	308.85	91.69	154.27	223.91
Thallium	0.55	1.64	2.16	0.49
Vanadium	39.40	1.04	1.14	39.15
Zinc	88.92	88.61	57.65	41.02
Cyanide	NR	NR	NR	NR

NOTE: All metals are reported in mg/kg.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table 11. Average Values for Sediments Collected in the 100 Areas[a].

Constituent	Reactor Site Sample Locations						
	BC	K	N	D	H	F	Han. Tow
Aluminum	5916.00	5797.00	5604.00	6200.00	6632.00	6051.00	8327.00
Antimony	12.30 UJ	10.90 UJ	8.20 UJ	4.55 UJ	12.88 UJ	10.20 UJ	6.20 UJ
Barium	55.20 B	80.30 J	73.06	71.10	61.04 J	59.80 J	86.70 B
Beryllium	0.33 U	0.27 U	0.22 U	0.25 U	0.34 U	0.34 U	0.40 U
Cadmium	0.83 U	0.69 U	0.59 U	1.08 UJ	0.81 U	0.95 U	1.79 U
Calcium	3150.00	3190.00	3152.00	4530.00	4256.00	4833.00 J	4800.00
Chromium	46.50 J	34.60	11.64 J	76.05 J	48.70 J	15.50 J	18.70
Cobalt	5.70 J	6.60 B	7.70 B	6.85 B	7.70 B	7.50 B	10.00 B
Copper	15.30	18.20 J	16.50 J	14.40	26.80 J	18.90 J	23.10 J
Iron	12700.00	16700.00	15960.00	92600.00	16040.00	49485.00 J	24734.00
Magnesium	3406.00	3220.00	3268.00	3560.00	3924.00	4056.00	4390.00
Manganese	180.30	355.00 J	408.00 J	370.00 J	294.20 J	266.00 J	341.00 J
Nickel	11.40 B	12.50	11.90	9.90	12.18	11.70	17.10
Potassium	987.30 B	691.00 B	655.20 B	668.00 U	795.20 B	749.00 B	1058.00 B
Silver	1.20 U	0.92 U	0.96 U	0.80 B	1.09 U	1.06 U	2.03 U
Sodium	148.00 J	175.00 J	152.80 J	170.50 U	233.80 J	211.00 J	239.00 J
Vanadium	25.40	33.20	37.68	31.70 J	32.32	40.80	66.30
Zinc	129.10	177.70 J	117.02 J	143.00 U	237.00	153.00 J	262.00
Cs-137	0.15	0.18	0.16	0.25	0.26	0.32	0.36
Sr-90	0.30	0.46	46.20	-0.04	0.72	8.80	1.40

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

[a]Data from DOE/RL-92-12, Rev. 1 (Sampling and Analysis of 100 Areas Springs), May 1992 (DOE-RL 1992b).

B = Analyte found in associated blank as well as sample.
J = Not detected, associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected, value reported is sample quantitation limit.
UJ = Not detected, may not accurately reflect sample quantitation limit.

Table 12. Soil Background Values (ppm) for Selected Metals Reported for the Hanford Site[a].

Constituent	Sample Identification Numbers						
	B00ZH9	B00ZJ0	B00ZJ1	B00ZJ2	MIN	MAX	AVG
Aluminum	7100	7800	8100	8100	7100	8100	7775
Barium	80	88	96	89	80	96	88.25
Calcium	3600	3600	4900	5100	3600	5100	4300
Chromium	8	9	9	8	8	9	8.5
Cobalt	12	11	13	13	0	13	9.25
Copper	9	11	14	13	9	14	11.75
Iron	23000	22000	24000	24000	22000	24000	23250
Lead	6	7	6	6	6	7	6.25
Magnesium	3900	4000	4600	4800	3900	4800	4325
Manganese	340	360	410	360	340	410	367.5
Nickel	8	9	11	10	8	11	9.5
Potassium	1500	1600	1400	1300	1300	1600	1450
Sodium	150	160	170	180	150	180	165
Strontium	20	21	22	23	20	23	21.5
Thallium	ND	ND	ND	ND	0	0	0
Vanadium	64	59	63	63	59	64	62.25
Zinc	43	44	42	42	42	44	42.75

[a]DOE/RL-88-41, Rev. 2, 1993.

Table 13. Soil Threshold Values (ppm) and Cleanup Standards.

Analyte	Hanford soil background[a]		Ritzville silt loam[b]	World wide[c]		Cleanup standard[d]
		Maximum		Mean	Range	
Aluminum	16,600	28,800	63,100	71,000	10,000 - 3000,000	
Antimony	15.7	52.2	0.42	1	0.2 - 10	32
Arsenic	9	32.5	4.6	6	0.1 - 40	.59
Barium	175	480.0	510	500	100 - 3,000	5,600
Beryllium	1.8	10	0.9	0.3	0.01 - 40	.23
Cadmium	0.66	11	0.29	0.35	0.01 - 2	80
Calcium	24,600	105,000	18,300	15,000	700 - 500,000	--
Chromium	28	53	43	70	5 - 1,500	8,000
Cobalt	19	110	7.9	8	0.05 - 65	--
Copper	30	61	26	30	2 - 250	2,960
Iron	38,200	68,100	43,700	40,000	2,000 - 550,000	--
Lead	15	74	10	35	2 - 300	1,120
Magnesium	9,160	32,300	11,200	5,000	400 - 9,000	--
Manganese	580	1,110	620	1,000	20 - 10,000	16,000
Mercury	N/Av		0.017	0.06	0.01 - 0.5	24
Nickel	25	110	29	50	2 - 750	1,600
Potassium	3,090	7,900				
Selenium	23		0.30	0.4	0.01 - 12	240
Silver	2.1	4.5	0.10	0.05	0.01 - 8	240
Sodium	1,390	5,120	21,400	5,000	150 - 25,000	--
Strontium	43					
Thallium			0.33	0.2	0.1 - 0.8	5.6
Titanium	3,307	--	--	5,000	150 - 25,000	--
Vanadium	107	140	130	90	3 - 500	560
Zinc	79	366	70	90	1 - 900	16,000

[a]Provisional threshold values based on acid leach--U.S. Environmental Protection Agency (EPA) Method 6010 (Hoover and Legore 1991).
[b]Wildung et al. 1986.
[c]Bowen 1979.
[d]Model Toxic Control Act.
N/Av = Not available.

Table 14. Maxima and 95/95 Reference Thresholds for Sitewide Soil Background[a].

Analyte	Detection limits		95/95 threshold (mg/kh)	Maximum concentration (mg/kg)	Sample with maximum concentration
	LOD	LOQ			
Aluminum	21.8	66.1	15,100	28,800	TOPSOIL, PLAYA, E-7
Antimony	15.7	52.2	NC	31	VOLCANIC ASH*
Arsenic	N/A	N/A	9.0	27.7	TOPSOIL, JUNIPER, E-3
Barium	0.87	2.7	175	480	VOLCANIC ASH*
Beryllium	N/A	N/A	1.8	10	VOLCANIC ASH*
Cadmium	0.24	0.79	NC	11	VOLCANIC ASH*
Calcium	175	470	24,600	105,000	TOPSOIL, GREASEWOOD, E-2
Chromium	1.1	3.0	28	320	RINGOLD FM*
Cobalt	0.88	2.9	19	110	VOLCANIC ASH*
Copper	2.1	6.2	30	61	VOLCANIC ASH*
Iron	75.7	236	38,200	38,100	RINGOLD FM
Lead	N/A	N/A	14.9	74.1	TOPSOIL, JUNIPER, E-3
Magnesium	18.4	57.9	9,160	32,300	TOPSOIL, GREASEWOOD, E-2
Manganese	0.63	1.8	583	1,110	TOPSOIL, PLAYA, E-7
Mercury	N/A	N/A	1.3	3.8	RANDOM SAMPLES, #15
Nickel	2.4	7.7	25	200	RINGOLD FM*
Potassium	135	451	3,090	7,900	TOPSOIL, PLAYA, E-7
Selenium	N/A	N/A	NC	6	RANDOM SAMPLES, #15
Silver	2.1	4.5	2.1	14.6	RANDOM SAMPLES, #6
Sodium	50.6	140	1,390	6,060	RANDOM SAMPLES, #12
Thallium	N/A	N/A	NC	3.7	LAB DETECTION LIMIT
Vanadium	1.8	5.9	107	140	VOLCANIC ASH*
Zinc	6.4	15.6	79	366	TOPSOIL, JUNIPER, E-3

*Offsite.

[a]DOE/RL-92-24, 1993.

N/A = Not available.
NC = Not calculated.

between the threshold values for various metals, which indicates the need to develop some standard references for metal background values at the Hanford Site. Because other Hanford Site documents, such as Peterson and Johnson (1992), used the soil threshold values reported by Hoover and Legore (1991) (DOE-RL 1993), this report also uses them for data comparison. Maximum values of heavy metals concentrations that were collected at the Hanford Site (Hoover and Legore 1991) are provided in Table 14 to indicate the wide variation of concentration values and to show that values that may exceed the threshold values are not necessarily cause for concern. The soil threshold values reported by Hoover and Legore (1991) represent the upper limit of the 95% confidence level.

Only recent information exists at the Hanford Site for metals concentrations in flora and fauna. Some limited data is available on metals in phytoplankton and caddis flies collected from the Columbia River (Cushing 1979 and 1993) and some information regarding uptake of metals by plants and animals in the 300 Areas (300-FF-1) at the Hanford Site (Brandt and Rickard 1992). The latest information (Cushing 1993) regarding uptake of metals by aquatic organisms showed undetectable levels of chromium in caddis fly larvae and chromium levels that were essentially the same for samples collected at the 100 Areas operable units and control samples. For reference purposes, the heavy metals in vegetation presented in this report can also be compared with plant toxicity levels for selected metals in Table 15.

Vegetation samples collected in the 300-FF-1 operable unit (Brandt and Rickard 1992) that were analyzed for metals indicated very low levels. A summary of the findings in that study indicated that direct human health risk from metals in vegetation outside exclusion fences is minimal.

Some plants and animals do select and/or concentrate various metals and other inorganic constituents based on life history phenomena, soil type, etc. (Adriano 1986). An example of differential uptake is in earthworms, which can concentrate heavy metals from soils many times the soil metal levels. Earthworms found in soils with 2.0 ppm of cadmium contained 100 ppm of the heavy metal (Beyer et al. 1982). Another illustration of the large amount of variability in uptake of metals between species is shown in Table 15 (regarding toxicity levels). Some species can tolerate much higher levels of various metals than others.

Radionuclide data are compared with soil and vegetation samples collected by Westinghouse Hanford as part of the operational monitoring program in the 100 Areas from 1981 to the present (Appendix H) and with uranium values in asparagus collected in the 300 Areas (Tiller and Poston 1992). Radionuclide levels in trees also are compared with previous radionuclide uptake studies by trees at the Hanford Site (Landeen and Mitchell 1986 and Rickard and Price 1989).

8.1 SOURCES OF METALS AND RADIONUCLIDES

Possible sources of metals and radionuclides found at the Hanford Site that could explain some of the values observed in this and other reports are discussed in Peterson and Johnson (1992). The following information that

Table 15. Toxicity Levels of Selected Metals in Plants. (sheet 1 of 2)

Constituent	Plant species	Toxic levels (ppm)	Reference
Zinc	corn	>450	Gall and Barnette 1940
	cowpeas	>180	Gall and Barnette 1940
	cotton	200	Chapman 1966
	tomatoes	526	Chapman 1966
	oats	1,700	Ohki 1975
	apples	>100	Benson 1966
	lettuce	>500	MacLean 1974
	alfalfa	>700	MacLean 1974
	peas	>50	Melton et al. 1970
Cadmium	spinach	4 (in soil)	Adriano 1986
	rice	>600 (in soil)	Adriano 1986
	corn	>2.5 (in soil)	Miller et al. 1977
	soybeans, wheat	>2.5 (in soil)	Haghiri 1973
	clover	>5 (in soil)	Williams and David 1977
	barley	15	Davis et al. 1978
Chromium	barley, corn	5	Pratt 1966
	oats, citrus		
	tobacco	175	Pratt 1966
	rice	>35	Chino 1981
Copper	rice	>20	Chino 1981
	citrus	>150 (in soil)	Baker 1974
	snapbeans	>20 (in soil)	Walsh et al. 1972
Lead	barley	>35	Davis et al. 1978
	rice	>50	Chino 1981
	Japan plants	>400 (in soil)	Chino 1981
Manganese	apple	>400 (in soil)	NAS 1973
	wheat	>350 (in soil)	NAS 1973
	alfalfa	>477	NAS 1973
	barley	>300	NAS 1973
Nickel	general plants	>50	Adriano 1986
	ryegrass	>90 (in soil)	Khalid and Tinsley 1980
	rice	20-50	Chino 1981
	barley	26	Davis et al. 1978
	hardwoods	100-150	Lozano and Morrison 1981

Table 15. Toxicity Levels of Selected Metals in Plants. (sheet 2 of 2)

Constituent	Plant Species	Toxic Levels (ppm)	Reference
Selenium	wheat	40 (in soil)	Beath et al. 1937
	cotton	20 (in soil)	Adriano 1986
	fescue	117	Walsh and Fleming 1952
	meadow sweet	30	Walsh and Fleming 1952
	barley	>7	Walsh and Fleming 1952
	alfalfa	>2 (in soil)	Soltampour and Workman 1980
Barium	bush beans	>2,000 (in soil)	Chaudry et al. 1977
	barley		
Silver	barley	4	Davis et al. 1978
	bush beans	>5	Wallace et al. 1977
Thallium	crops	>7	Carson and Smith 1977
	tobacco	>1 (in soil)	Carson and Smith 1977
Vanadium	plants in general	>1	Davis et al. 1978

discusses these sources was obtained from their report. Concentrations of some metals in sediments found in the 100 Areas may be influenced by upstream sources such as mining and related refining activities in the upper Columbia River drainages. These areas include Sullivan, British Columbia, Republic, and Metaline, Washington, as well as Coeur d'Alene, Idaho. Above-background occurrences of such metals as lead, zinc, copper, and cadmium may come from these sources (Maxfield et al. 1974; Johnson 1991 and 1979; Rember et al. 1991; Robbins 1978; Silker 1964; and Miller et al. 1975). Metals such as antimony, thallium, arsenic, and manganese also are associated with British Columbia mining activities (Hoy et al. 1985). Studies conducted behind Priest Rapids and McNary dams (Whetten et al. 1969) showed that zinc concentrations were approximately eight to five times higher than natural background. Similar patterns were observed for lead, cadmium, and copper (Whetten et al. 1969). Chromium concentrations especially at 100-D and 100-H reactors are probably the result of past liquid disposal practices associated with the reactors.

Peterson and Johnson (1992) also reported elevated levels of strontium-90 in seepage at 100-N, 100-K, and 100-H reactors, the probable cause of the elevated strontium-90 levels in trees at 100-K reactor reported in the following sections.

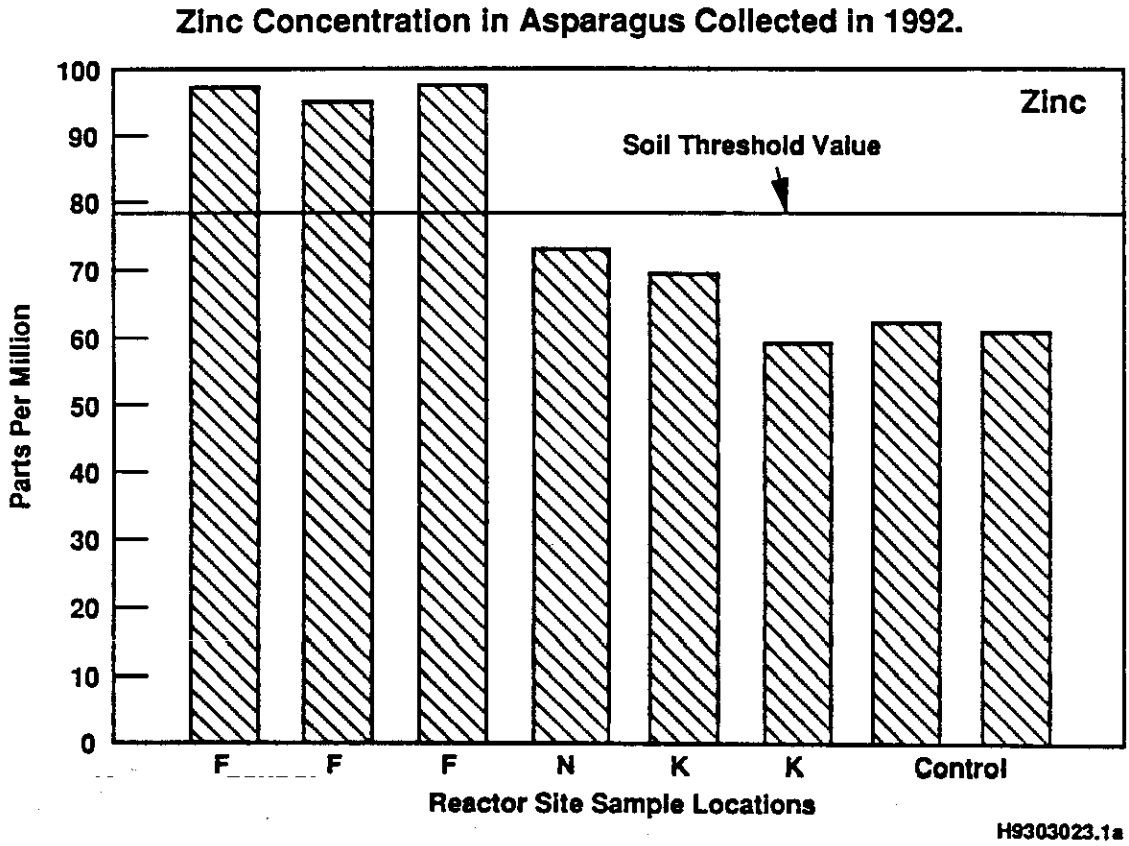
Appendix J graphically shows average values for selected metals in all media, including control values collected as part of the 100 Areas ecological surveys and other similar sampling efforts. These figures are included to provide perspective and comparisons of the metals data that has been collected at the Hanford Site.

8.2 ASPARAGUS

The analytical results from the asparagus sampling are given in Tables B-1 and B-2 in Appendix B. Results from this effort show that levels of metals and radionuclides collected in 1991 and 1992 in asparagus are very low, with the possible exception of zinc. Zinc concentrations from asparagus collected at 100-F indicated levels up to 97 ppm, which is higher than the soil threshold value of 79 ppm (Figure 1). However, the average values of zinc in asparagus collected in the 100 Areas and the offsite control samples were essentially identical (59 and 58 ppm, respectively). These results are also similar to the zinc values reported in tree leaves collected in 1991 and milfoil collected at N Springs (see Section 8.4). In both instances, the zinc values were higher than the soil threshold limit of 79 ppm. Toxic levels of zinc from Table 15 in plants indicates concentrations ranging from 50 ppm in peas to 1700 ppm in oats. There were no visible signs of stress associated with the asparagus sampled in this study.

Chromium concentrations were very low in asparagus, with the majority of the results undetectable. Chromium is a metal of concern at the Hanford Site and has been detected in groundwater samples from the 100 Areas (Peterson 1991, Peterson and Connelly 1992). Chromium seems to be translocated poorly in plants, and "normal" soils concentrations in plants are usually less than 1 ppm (Pratt 1966).

Figure 1. Zinc Concentration in Asparagus (1992).



Average aluminum, barium, lead, iron, manganese, magnesium, and vanadium concentrations in asparagus were the lowest for all media sampled (Appendix J). Potassium concentrations in asparagus, including the controls, were among the highest levels observed, second only to trees.

Technetium-99, strontium-90, and cesium-137 were below detection limits in asparagus. The only other radionuclide data available in asparagus from the Hanford Site are uranium concentrations from the 300 Areas (Tiller and Poston 1992), which were low.

8.3 REED CANARYGRASS

The analytical results for reed canarygrass are given in Tables C-1 through C-13 of Appendix C. Metals concentrations in reed canarygrass were among the lowest of all the various media that were sampled (Appendix J) and exhibited the same basic trends as asparagus. For the majority of the metals, reed canarygrass values were higher in the control samples. Reed canarygrass, like many of the media, showed elevated levels of zinc compared to the soil threshold level of 79 ppm. However, the majority of all the media sampled (including the controls) showed this same trend, indicating that these levels of zinc are probably normal for vegetation growing in the Hanford Site environs.

Radionuclide values for cesium-139, strontium-90, and technetium-99 were very low or undetectable and very rarely exceeded 1 pCi/gm. These values are comparable to or less than the values reported in vegetation from the 100 Areas as part of Westinghouse Hanford's routine monitoring program (Appendix H).

8.4 TREE LEAVES AND LIMBS

The analytical results from the tree leaves are given in Tables D-1 through D-3 of Appendix D. Analytical results from tree leaves collected in 1991 at 100-D, 100-H, and 100-BC reactors showed up to 2.4 pCi/g strontium-90 and 2.0 pCi/g technetium-99. Tree leaves collected in July of 1992 did show elevated levels of strontium-90 up to 35 pCi/g (Table D-2) from samples collected near 100-K reactor. To verify these results, a follow-up sampling effort was conducted in October 1992. Twelve samples of tree limbs and leaves were sampled in the vicinities of BC and K reactors from six mulberry trees, including the same tree that had a measured strontium-90 concentration of 35 pCi/gm. The follow-up samples from this same tree indicated strontium-90 levels of 43.0 pCi/gm in the limbs and 88.0 pCi/gm in the leaves. Two other trees sampled below BC reactor had strontium-90 levels ranging from 7.1 pCi/gm to 23.0 pCi/gm (Table D-3). These results are graphed in Figure 2.

Other Hanford Site studies have been conducted to record cesium-137 and strontium-90 levels in trees. Landeen and Mitchell (1986) sampled trees at 216-U-10 Pond before it was decommissioned and found elevated levels of these radionuclides in the roots, cores, and leaves. The levels they reported for these radionuclides were higher than anything found in the trees growing along

the Columbia River. Rickard and Price (1989) analyzed tritium concentrations in locust trees near K reactor and found levels comparable to those reported in this report.

Figure 3 shows levels of copper and zinc in tree leaves. Tree leaves collected in 1991 had higher levels of both zinc and copper than tree leaves that were collected in 1992. Copper is one of the seven micronutrients essential for normal plant nutrition. Kubota (1983) conducted a nationwide survey and found average levels of 8.4 ppm in legumes and 4 ppm in grasses. Studies of copper distributions and levels in forest ecosystems have shown that copper tends to accumulate in the organic matter. One Sweden study (Tyler 1972) of a forest ecosystem had copper values ranging from 2 to 660 ppm.

In general, metals concentrations in tree control samples were higher than those collected on the Hanford Site, with the exception of magnesium and potassium. Trees had higher concentrations of magnesium and potassium than any other medium (Appendix J).

8.5 WATER MILFOIL

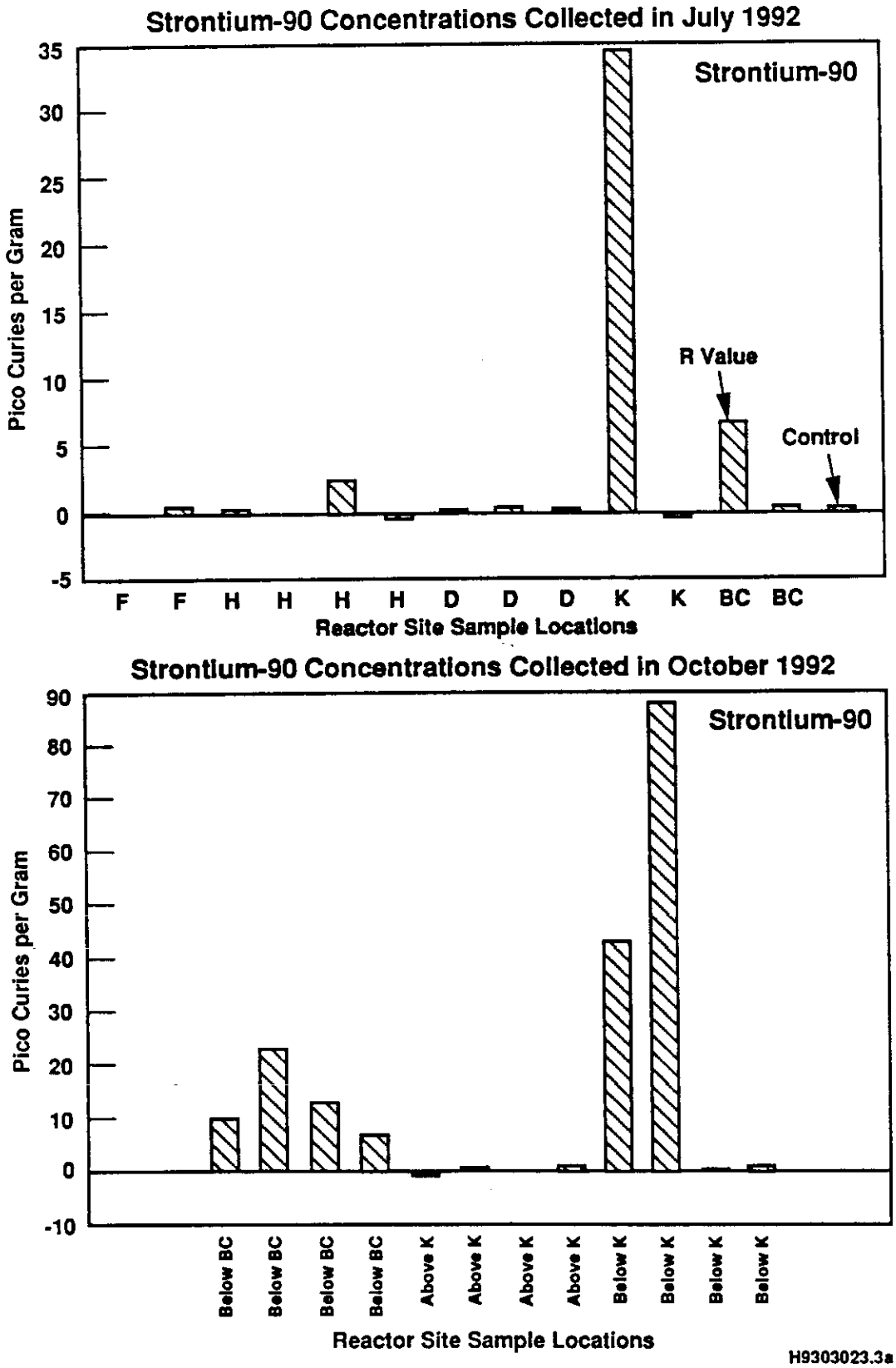
The analytical results from the three water milfoil samples are provided in Table D-4 of Appendix D. Milfoil is an aquatic plant that may have more opportunity to take up hazardous waste constituents from the river sediments and water. Milfoil was one of the few media that had higher values for the majority of the metals in the Hanford Site samples than in the control samples. Cadmium, lead, copper, and manganese concentrations in milfoil were higher than for all other media sampled in the 100 Areas, and concentrations of nickel in milfoil were second only to the 100 Areas river sediments (Appendix J). Sodium concentrations were the highest for all vegetation samples. The results also indicated that the levels of antimony, cadmium, lead, and zinc sometimes exceeded the soil threshold values from Table 14 including the control samples (Figure 4). The antimony values were all data qualified as undetectable.

These results may be considered normal for milfoil; however, as already indicated, no background values are available for milfoil at the Hanford Site. Also, these results could indicate possible contamination from outside sources as discussed in Section 8.1.

The average concentration of zinc values in milfoil [246 ppm (Table D-4)] are similar to the average zinc concentrations in Columbia River sediments (174 ppm) collected in 1991 (DOE-RL 1992b), which may indicate a correlation between aquatic species, such as milfoil, and the river sediments.

Normally, cadmium is taken up in small amounts by plants. Normal levels of cadmium in food crops is around 0.5 ppm (Friberg et al. 1971). Foliage of sugar maple in New Hampshire and Vermont had cadmium concentrations in the range of 0 to 5 ppm (Smith 1973). Plants growing in areas of the world with soil known to be contaminated with cadmium have been documented to contain levels up to 600 ppm (Adriano 1986).

Figure 2. Strontium-90 Concentrations at Reactor Sites (1992).



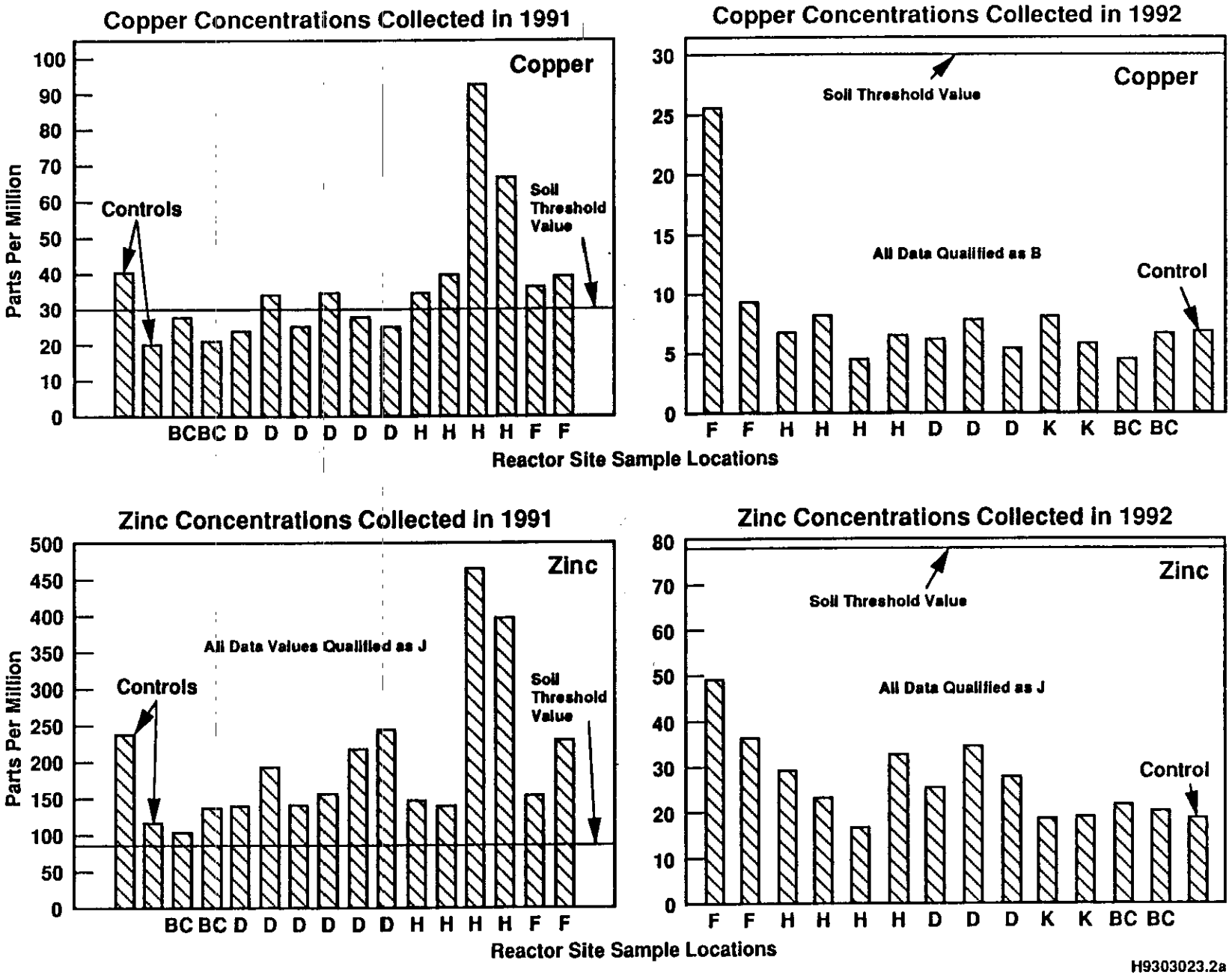


Figure 3. Copper and Zinc Concentrations at Reactor Sites (1991 and 1992).

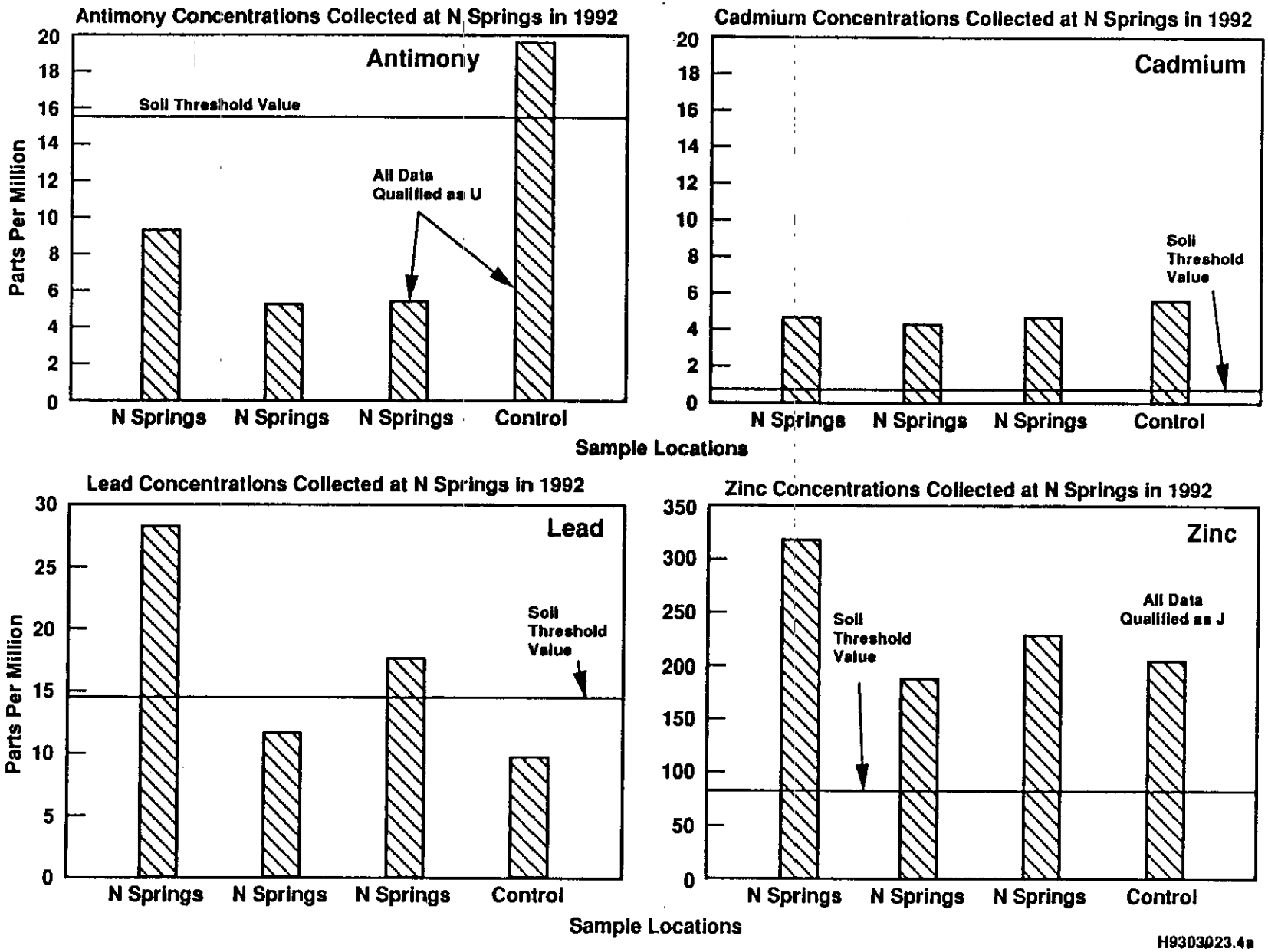


Figure 4. Antimony, Cadmium, Lead, and Zinc Concentrations at N Springs (1992).

Lead concentrations in plants can be attributed to root uptake and external deposition. Plants growing in soils known to have high lead concentrations also can have high lead concentrations. Marten and Hammond (1966) showed uptake of lead by bromegrass in sandy soils up to 680 ppm.

The general knowledge regarding antimony levels in soils and plants is minimal. Normal antimony levels in most terrestrial plants seem to be around <0.1 ppm (Adriano 1986).

Strontium-90 concentrations in milfoil ranged from 0.18 to 0.61 pCi/gm at N Springs. Similar values were reported by Antonio et al. (1993) in milfoil at 100-N with values ranging from 0.11 to 0.14 pCi/gm of strontium-90. Control values in both studies collected above Vernita Bridge ranged from -0.04 to 0.08 pCi/gm. In this study, cesium-137 was detected in only one sample at 0.19 pCi/gm.

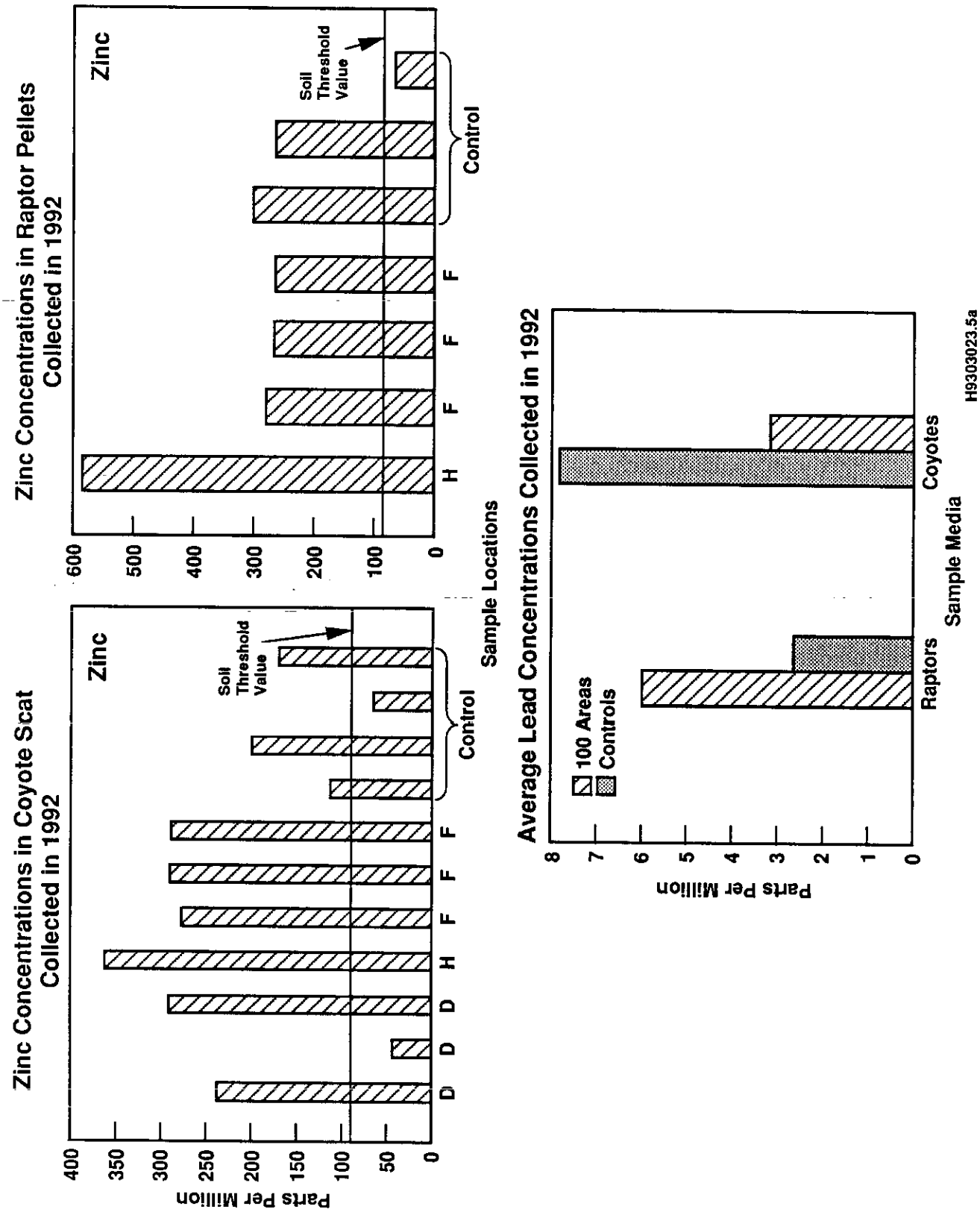
8.6 ANIMALS (COYOTES AND RAPTORS)

Results from the coyote scat and raptor pellets indicated low levels of metals and radionuclides, except for of zinc (Tables E-1 and E-2 of Appendix E). Zinc values in coyote scat and raptor pellets exceeded the soil threshold value of 79 ppm (Figure 5). The control samples also exceeded 79 ppm, which indicates that this may be a normal body burden based on the diet of this species. Coyotes are omnivorous and will eat a wide variety of plant and animal species. Raptors, however, are almost exclusively carnivorous so the zinc values may represent normal values in the prey base. Various species of small mammals, snakes, and insects throughout the 100 Areas would have to be sampled to determine background levels of metals. Talmage and Walton (1991) found a relationship between contaminants in soil or food and selected target tissues in small mammals. Heavy metals showed a close relationship, with the kidney being the best assay organ except for bone, which was best for lead.

The results from this study did not indicate that lead concentrations in raptors and coyotes were much different than for soil collected at 2101-M Pond on the 200 Areas plateau and in the ant mounds and small mammal burrows. However, average lead concentrations in both coyotes (7.83 ppm) and raptors (5.98 ppm) were higher than the control samples (2.63 ppm and 3.18 ppm, respectively) (Figure 5). Heavy metal concentrations of lead, cadmium, nickel, and zinc in small mammals can be directly correlated with vehicle traffic volume (Scanlon 1979). Another study by Wheeler and Rolfe (1979) showed that the distribution of lead in soil and vegetation along roadsides seemed to follow a double-exponential function. The first exponent is associated with large particles that settle out rapidly, usually within 5 m of the highway; and the second exponent is associated with smaller particles that settled out more slowly, within about 100 m of the source. Some of the raptor pellets and coyote scat collected in the 100 Areas were along roads that are used frequently.

Average concentrations of aluminum, cadmium, chromium, cobalt, copper, iron, lead, magnesium, nickel, potassium, and vanadium were slightly higher in coyote scat than in the raptor pellets. Raptor pellets had higher concentrations of sodium and zinc than the coyote scat.

Figure 5. Zinc and Lead Concentrations for Coyote Scat and Raptor Pellets (1992).



8.7 ANT MOUNDS

Tables showing the analytical results of the soil collected from the ant mounds are presented in Tables F-1 through F-5 of Appendix F. Results of the metals analyses indicated levels that were low or undetectable for many of the metals. The average concentrations in the control samples were higher than in samples collected on the Hanford Site.

Chromium levels in the ant mounds averaged 7.01 ppm, compared to an average of 35.96 ppm reported from the Columbia River sediment sampling effort (DOE-RL 1992b) (Appendix J).

Radionuclide results for strontium-90 and cesium-137 were all undetectable or less than 1 pCi/gm. The radionuclide levels here are comparable or less than the levels reported in soil by Westinghouse Hanford's routine monitoring program for the 100 Areas (Schmidt et al. 1992). Evidence from the limited number of ant mounds sampled from this study does not indicate that ants are bringing up radionculides and exposing them to the surface. However, a more intensive sampling effort would need to be conducted on any specific waste sites of interest.

8.8 SMALL MAMMAL BURROWS

The analytical results of the soil collected from the small mammal burrows are presented in Tables G-1 through G-6 of Appendix G. These results were very similar to the results reported for the ant mounds.

Small mammal burrows generally exhibited higher levels of aluminum and chromium compared to all other media sampled (Appendix J), but the levels were still substantially below those considered to be of environmental concern. The chromium levels in the small mammal burrows were well below the average chromium value of 35.96 ppm reported for the Columbia River sediments (DOE-RL 1992b). The average aluminum values for all the small mammal burrows including the control data are almost identical to those values reported as part of the 2101-M Pond study (Mitchell 1993).

The concentrations of cesium-137 and strontium-90 were very low or undetectable. Only one sample, collected at N reactor, exceeded 1 pCi/gm (strontium-90 level was 1.4 pCi/gm). The radionuclide levels in the small mammal burrows and ant mounds are generally comparable or lower than the levels reported for soil in the 100 Areas as part of Westinghouse Hanford's routine monitoring program (Schmidt et al. 1992). Like the ant mounds, the limited number of burrows sampled in this study do not indicate any significant problems with small mammals exposing underground contamination. However, mammal burrowing activity is dynamic and varies through time so continued monitoring at selected waste sites might be warranted.

9.0 SUMMARY AND RECOMMENDATIONS

9.1 DATA EVALUATION PROBLEMS

At the Hanford Site, the primary emphasis of the monitoring and surveillance programs and site characterization studies has been concerned with radionuclide concentrations in various media. These data-gathering efforts conducted by Westinghouse Hanford and PNL have provided information regarding radionuclide uptake in soils, plants, and animals.

Recently, the RCRA and CERCLA site characterization programs have dictated the need to analyze these same media for organics and other inorganic waste constituents such as heavy metals. This type of data is relatively new at the Hanford Site, and heavy metals information has been published only in the last year. According to some of the authors of these documents, questions have surfaced regarding how to quantify and/or present heavy metals information in some meaningful context.

The heavy metals data sets that are presented in this document in Appendixes B through G and other Hanford Site documents (e.g., Peterson and Johnson 1992 and Brandt et al. 1993) have indicated potential problems that can greatly effect how these data are interpreted and presented. Three areas of concern include analytical laboratory accuracy and precision, data validation qualifiers, and the variance observed in some of the duplicate samples.

PNL recently presented some data (Brandt et al. 1993) that indicated potential biases in analytical laboratory results. Analytical standards (pine needles and peach leaves) with known concentrations of heavy metals were sent to an analytical laboratory to serve as a quality-control check. The results of this effort indicated that many of the constituents were under or over reported by large factors. Concentrations of aluminum were underreported by 40% and iron by 25%. Uranium was over reported two to eight times and copper was over reported by two times. This is the same analytical laboratory that presented the data sets in this report.

The disposition of data with a particular data validation qualifier also seems to be treated differently by authors. No meaningful guidance relating to the disposition of data and associated data validation qualifiers was found. A wide diversity of opinion exists within the scientific community about which kinds of data and associated data validation qualifiers are appropriate for statistical treatments. Often a particular data set with an associated data validation qualifier may be used or rejected based on the same reason the data was qualified in the first place. For example, in the data validation process, a set of data for heavy metals may be validated as U[1], J[2], or UJ[3]. If the reason is because the holding times were missed by the

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[1] U=Not detected; value reported is sample quantitation limit.

[2] J=Not detected; associated value is estimated.

[3] UJ=Not detected; may not accurately reflect sample quantitation limit.

analytical laboratory and the data represents heavy metals information then the decision might be made to treat the results as real values, because metals will not decay with time. Many results were reported in this manner. The data in this report, particularly the duplicate samples, indicate that more variation occurs than would be predicted in some of the metals results. This can make data interpretation more difficult unless large sample sizes are involved, which usually is not possible.

Obviously, potential problems are associated with heavy metals data and care must be exercised before emphasizing a given concentration value or treating the data with standard statistical treatments. Perhaps the real value of the metals data being collected at the Hanford Site will be in observing relative trends over time.

9.2 SUMMARY

The data presented in this report represent a substantial database that can be used for comparative purposes in future sampling efforts at the Hanford Site. This report provides data for many types of media that are not normally sampled (e.g., grass, burrows, ants, asparagus, trees). The levels reported here for metals and radionuclides are well below those levels considered to be of environmental concern. The radionuclide levels for cesium-137 and strontium-90 are generally lower than those reported by Westinghouse Hanford in their annual surveillance and monitoring reports (Schmidt et al. 1992) since 1981 from the 100 Areas, except for some elevated strontium-90 levels in mulberry trees near 100-BC and 100-K reactors.

There were some interesting trends noted with the metals data, especially the zinc concentrations in all the media. Zinc values tended to be higher than the soil threshold values for all media sampled. If true background samples were collected and analyzed for zinc and other metals in all media at the Hanford Site, the results might indicate zinc levels comparable to what was reported in this study. Other metal/media combinations that were slightly elevated compared to the soil threshold values were copper in trees collected in July 1992; and antimony, cadmium, lead, and zinc in milfoil. Also, some data showed the difference in uptake between the various media that were sampled (Appendix J). For example, the lead concentrations in coyotes and raptors were obviously higher than the controls, which might indicate a need for further investigations. Aluminum and chromium concentrations in small mammal burrows were generally higher than for any other media.

9.3 RECOMMENDATIONS

Data is lacking at the Hanford Site for plant and animal background values. Meaningful comparisons are difficult to make in plants and animals given the absence of Hanford Site background metal and radionuclide values. The necessary background data should be collected at the Hanford Site in plants and animals in various soil types so that ongoing and future sampling efforts can provide more meaningful interpretations of the constituents that are being analyzed and, thus, better support remedial actions and clean up measures.

The sampling effort presented in this report is meant to serve as a general screening for pathways throughout the 100 Areas. A more intensive and site-specific effort may be required to answer specific questions at each operable unit.

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APPENDIX A

SAMPLE LOCATION MAPS FOR ALL MEDIA

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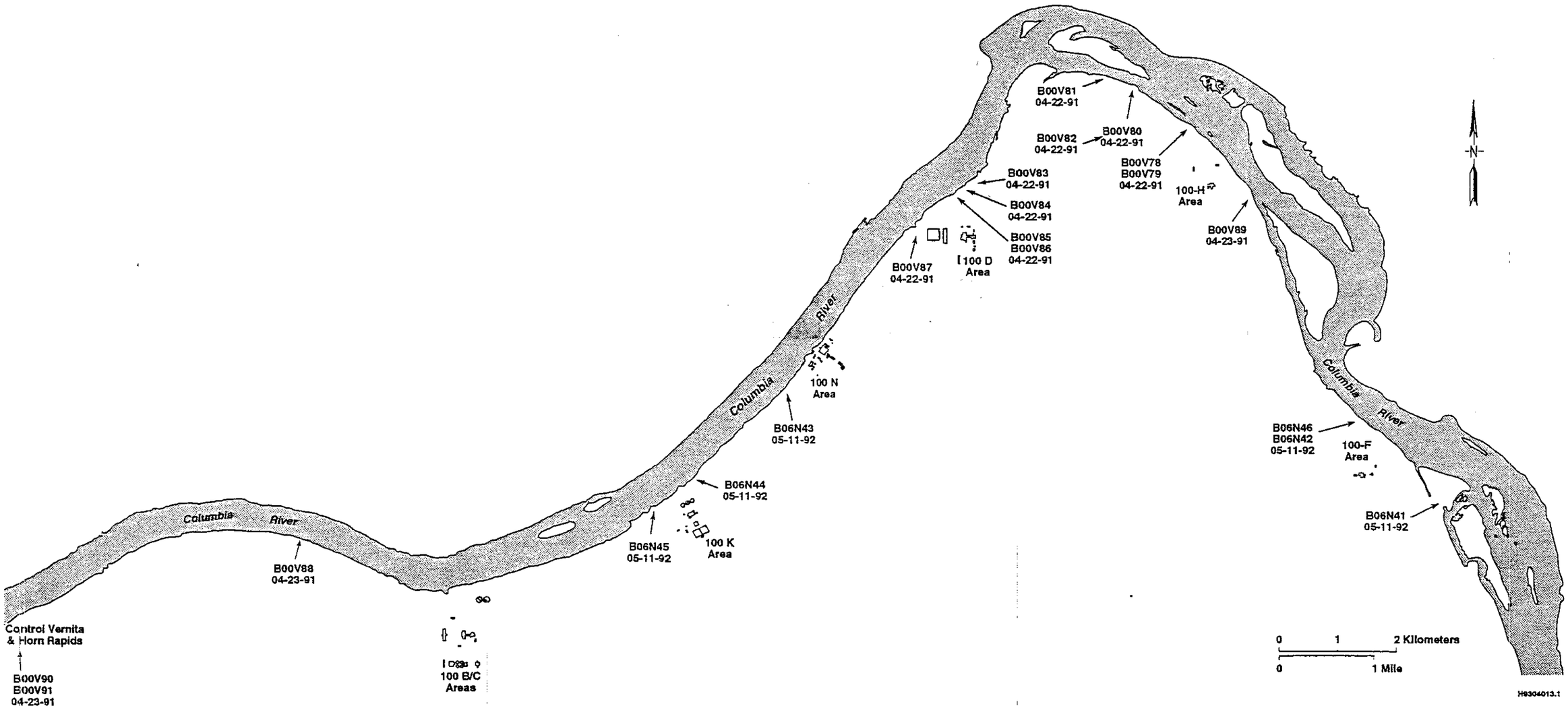

Figure A-1. Sample Locations and Identification Numbers for Asparagus Collected in 1991 and 1992.

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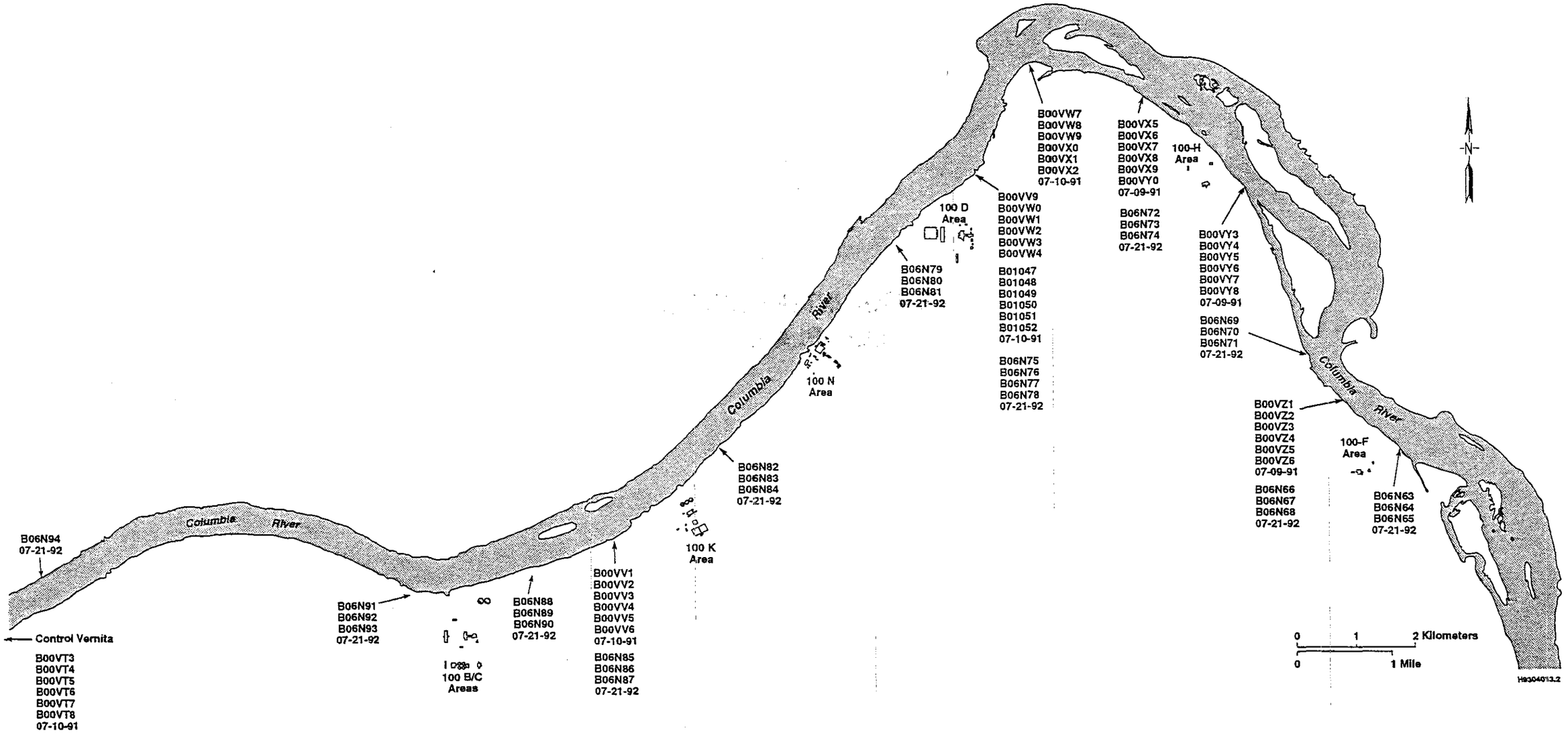

Figure A-2. Sample Locations and Identification Numbers for Reed Canarygrass Collected in 1991 and 1992.

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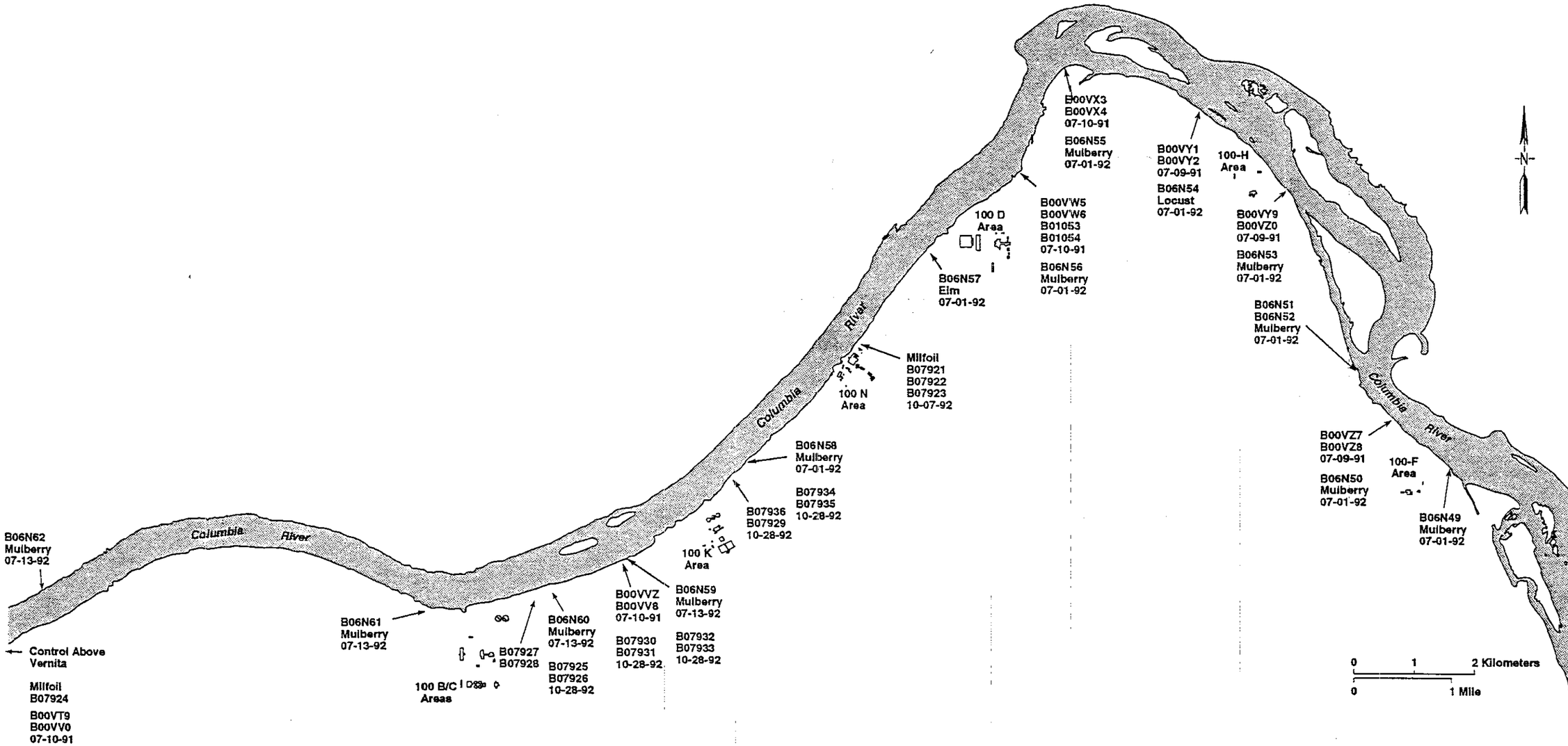

Figure A-3. Sample Locations and Identification Numbers for Trees and Milfoil Collected in 1991 and 1992.

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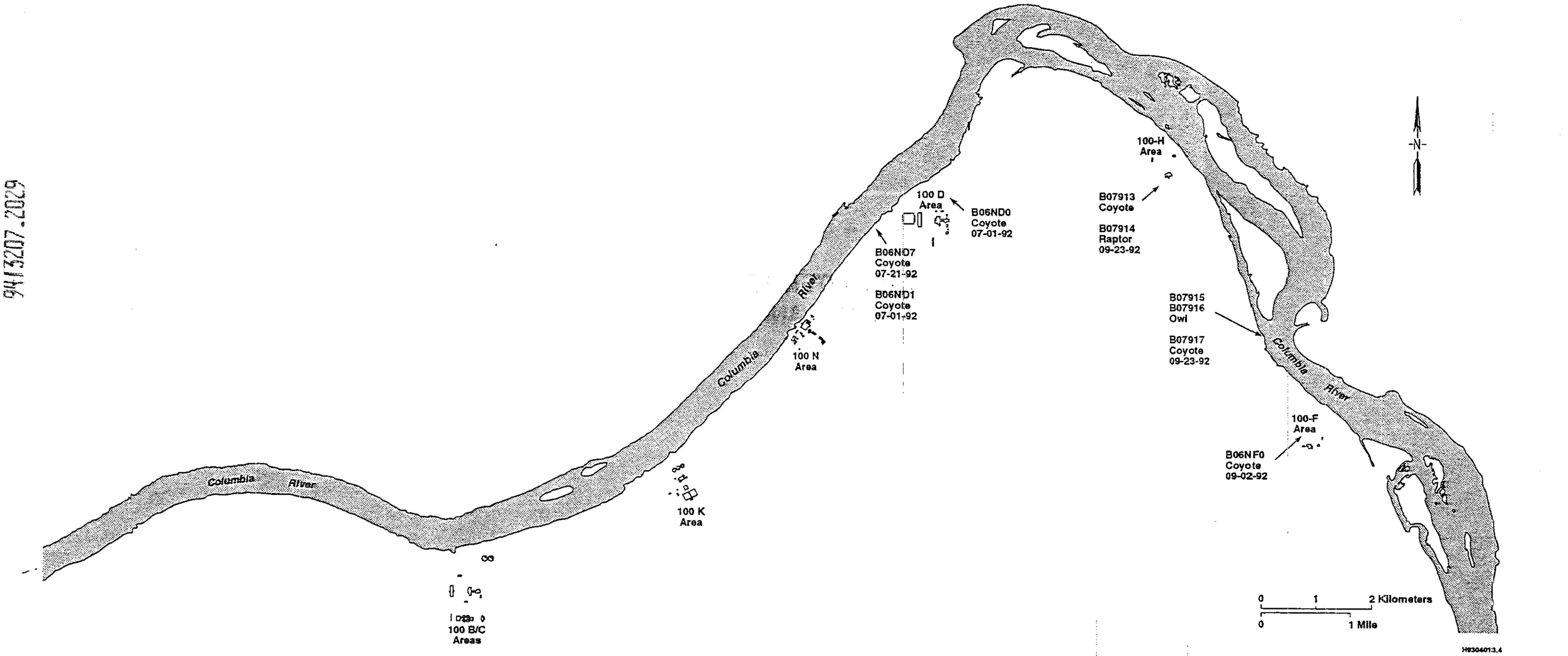

Figure A-4. Sample Locations and Identification Numbers for Raptor Pellets and Coyote Scat Collected in 1992.

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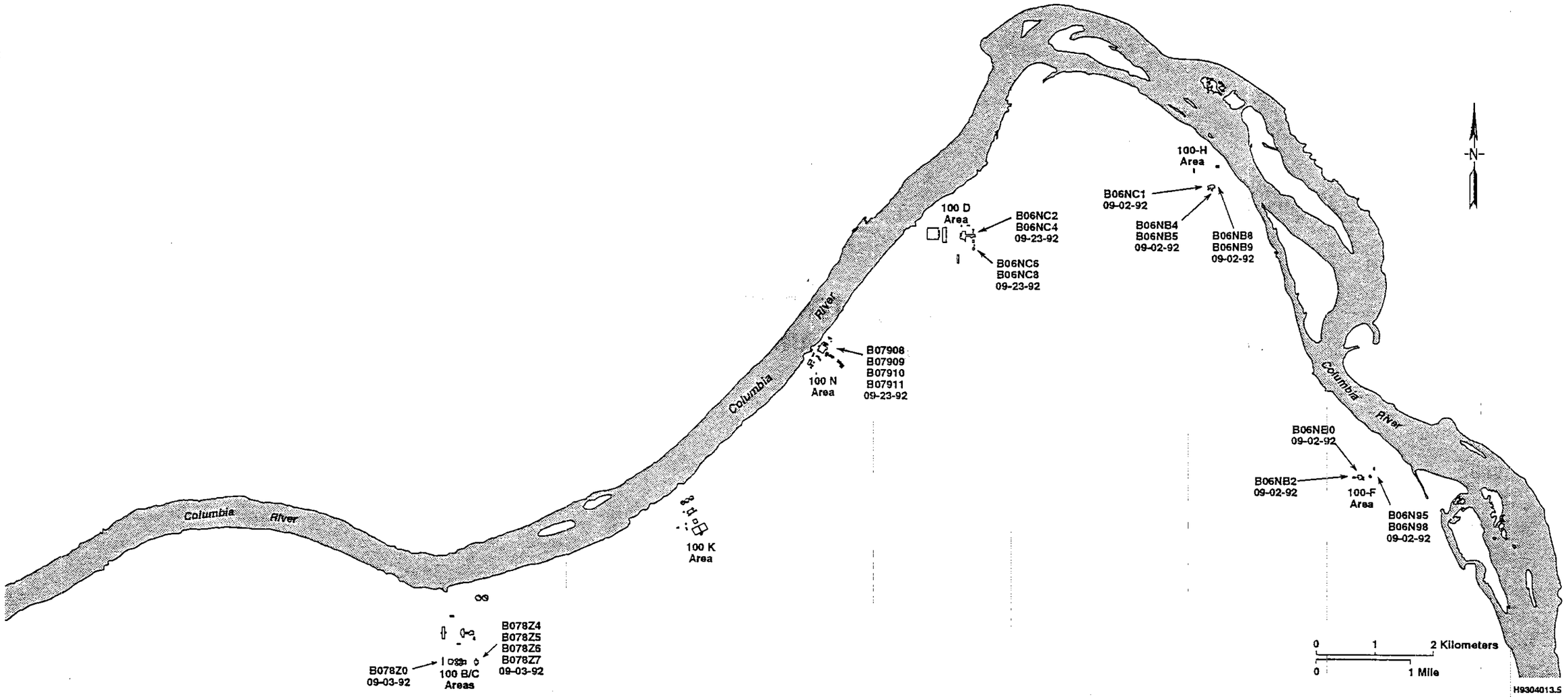

Figure A-5. Sample Locations and Identification Numbers for Ant Mounds Collected in 1992.

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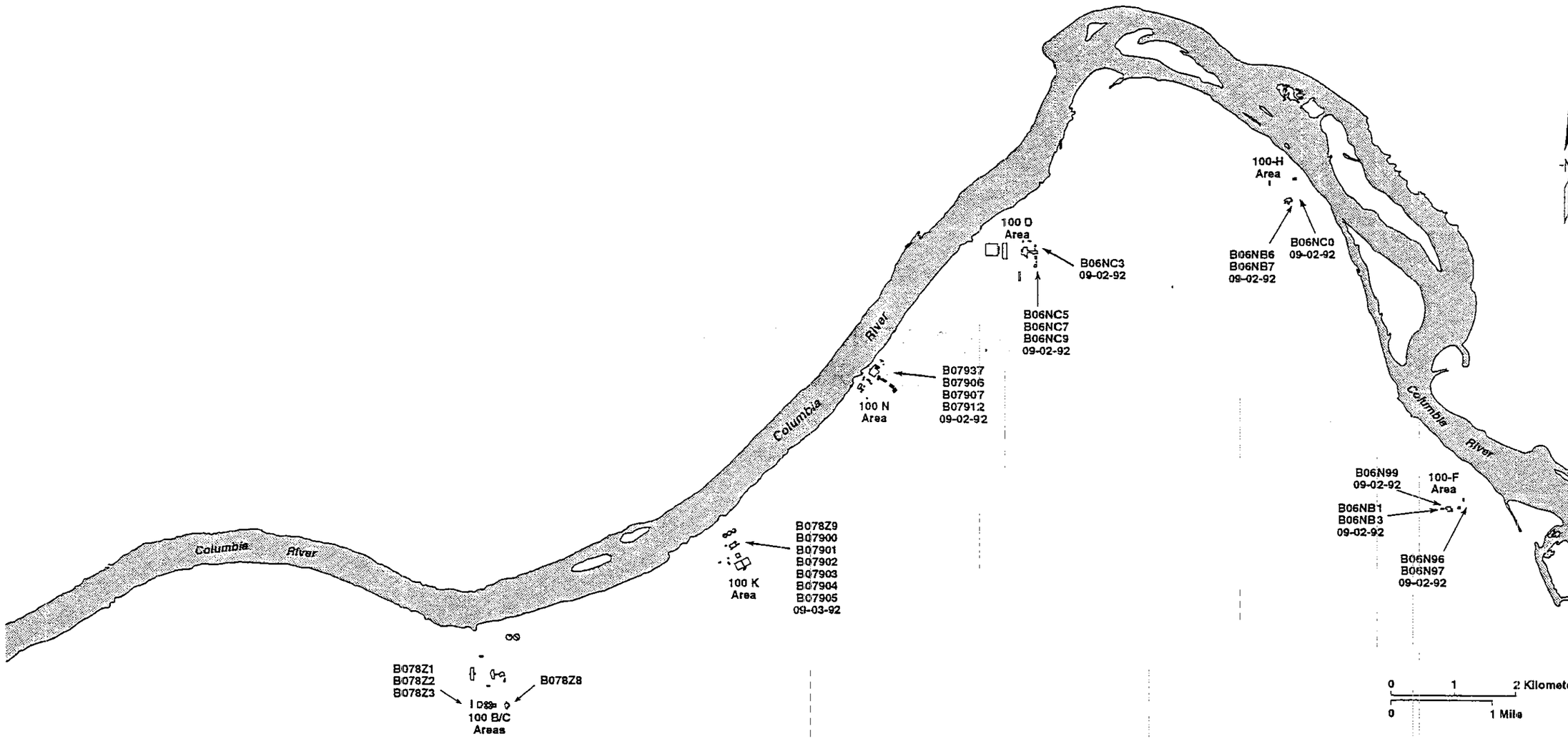

Figure A-6. Sample Locations and Identification Numbers for Small Mammal Burrows Collected in 1992.

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APPENDIX B

ANALYTICAL RESULTS FOR ASPARAGUS AND MILFOIL

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Table B-1. Asparagus Sample Results Collected from 100 Areas in 1991.
(sheet 1 of 2)

Constituent	Sample Identification Numbers and Sample Locations							
	Above H	Above H	Below D	Below D	Below D	Below D	Below D	Below D
	B00V78	B00V79	B00V80	B00V81	B00V82	B00V83	B00V84	B00V85
Aluminum	49.00 U	5.60 U	5.80 U	5.60 U	24.70 U	27.30 U	17.90 U	143.00 U
Antimony	3.60 U	3.50 U	3.70 U	3.40 U	3.50 U	3.50 U	3.60 U	3.60 U
Arsenic	0.84 UJ	0.83 UJ	0.80 UJ	0.85 UJ	0.83 UJ	0.81 UJ	4.00 UJ	4.20 UJ
Barium	3.50 U	3.00 U	2.30 U	1.90 U	4.80 U	2.20 U	1.90 U	6.00 U
Beryllium	0.21 U	0.21 U	0.21 U	0.20 U	0.20 U	0.21 U	0.21 U	0.21 U
Cadmium	0.63 U	0.62 U	0.64 U	0.60 U	0.61 U	0.63 U	0.63 U	0.63 U
Calcium	1360.00	1320.00	1050.00 B	1350.00	1620.00	925.00 B	1330.00	1570.00
Chromium	1.50 U	1.50 U	1.50 U	1.40 U	1.40 U	1.50 U	1.50 U	1.50 U
Cobalt	0.84 U	0.83 U	0.86 U	0.79 U	0.82 U	0.84 U	0.85 U	0.84 U
Copper	9.00	7.70	8.10	6.90	8.70	6.60	5.20 B	5.50
Iron	112.00 J	37.20 J	32.20 J	27.30 J	68.10 J	85.00 J	55.20 J	294.00 J
Lead	0.38 J	0.23 J	0.28 J	0.38 J	0.29 J	0.62 J	0.35 J	0.80 J
Magnesium	1180.00	1160.00	812.00 B	1020.00	1140.00	1310.00	1210.00	1260.00
Manganese	11.40	9.90	7.70	7.70	12.20	9.70	10.20	15.20
Mercury	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.09 UJ
Nickel	1.50 B	1.70 B	1.30 U	1.20 B	1.20 U	2.70 B	1.60 B	1.40 B
Potassium	25900.00	22200.00	17200.00	23800.00	21900.00	24900.00	25400.00	23200.00
Selenium	0.84 U	0.83 UJ	0.80 UJ	0.85 UJ	0.83 UJ	0.81 U	0.79 UJ	4.20 U
Silver	0.84 U	0.83 U	0.86 U	0.79 U	0.82 U	0.84 U	0.85 U	0.84 U
Sodium	162.00 U	104.00 U	355.00 J	91.50 U	95.10 U	161.00 U	122.00 U	194.00 U
Thallium	3.10 R	3.10 R	0.60 R	3.20 R	3.10 R	0.61 R	3.00 R	3.10 R
Vanadium	0.63 U	0.62 U	0.64 U	0.60 U	0.76 B	0.63 U	0.63 U	0.65 B
Zinc	50.30 U	45.80 U	36.30 U	40.30 U	40.60 U	50.30 U	43.00 U	50.10 U
Cyanide	NR	NR	NR	NR	NR	NR	NR	NR
Cs-137	<.1868	<.168	<.1816	<.2613	<.1415	<.1950	<.0972	<.1323
Sr-90	<.2254 UJ	<.2108 UJ	<.2172 UJ	<.2160 UJ	<.2137 UJ	<.2001 UJ	<.2290 UJ	<.1992 UJ
Tc-99	<.25	<.25 J	<.37 J	<.25 J	<.32	<.33 J	<.37	<.37 J

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table B-1. Asparagus Sample Results Collected from 100 Areas in 1991. (sheet 2 of 2)

Constituent	Sample Identification Numbers and Sample Locations					
	Below D	Below D	Control	Below H	Control	Control
	B00V86	B00V87	B00V88	B00V89	B00V90	B00V91
Aluminum	33.60 U	18.60 U	35.70 U	17.10 U	20.60 U	11.00 U
Antimony	3.50 U	3.70 U	3.40 U	3.40 U	3.40 U	3.50 U
Arsenic	4.00 UJ	0.82 UJ	0.84 UJ	0.85 UJ	0.83 UJ	0.90 UJ
Barium	3.90 U	2.10 U	5.60 U	2.90 U	4.80 U	1.70 U
Beryllium	0.21 U	0.22 U	0.20 U	0.20 U	0.25 U	0.21 U
Cadmium	0.62 U	0.64 U	0.60 U	0.59 U	0.60 U	0.62 U
Calcium	1580.00	1080.00	1550.00	1050.00	2040.00	1880.00
Chromium	1.40 U	1.50 U	1.40 U	1.40 U	1.40 U	1.50 U
Cobalt	0.83 U	0.86 U	0.79 U	0.79 U	0.80 U	0.83 U
Copper	5.10 B	6.30	5.50	6.00	5.90	7.20
Iron	81.80 J	50.00 J	65.40 J	64.80 J	50.60 J	40.40 J
Lead	0.41 J	0.34 J	0.40 J	0.40 B	0.42 J	0.64 J
Magnesium	1310.00	1030.00 B	984.00 B	1010.00	976.00 B	1120.00
Manganese	13.90	11.00	8.80	8.80	9.50	17.80
Mercury	0.10 UJ	0.09 UJ	0.09 UJ	0.09 UJ	0.10 UJ	0.10 UJ
Nickel	2.10 B	1.30 U	1.30 B	1.20 B	1.20 U	2.20 B
Potassium	23900.00	22700.00	20300.00	19500.00	20600.00	25900.00
Selenium	0.80 UJ	0.82 UJ	0.84 U	0.85 UJ	0.83 UJ	4.50 U
Silver	0.83 U	0.86 U	0.79 U	0.79 U	0.80 U	0.83 U
Sodium	145.00 U	102.00 U	116.00 U	168.00 U	141.00 U	106.00 U
Thallium	3.00 R	3.10 R	0.63 R	0.64 R	0.62 R	0.67 R
Vanadium	0.77 B	0.80 B	0.60 U	0.59 U	0.60 U	0.62 U
Zinc	49.00 U	39.00 U	41.70 U	43.90 U	32.40 U	39.50 U
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<.1589	<.2297	<.1082	<.1914	<.2666	<.1690
Sr-90	<.2241 UJ	<.2270 UJ	<.2162 UJ	<.2812 UJ	<.1478 UJ	<.1538 UJ
Tc-99	<.22 J	<.12	<.28	<.24	<.29	<.22

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table B-2. Asparagus Sample Results Collected from 100 Areas in 1992.

Constituent	Sample Identification Numbers and Sample Locations							
	Below F	Above F	Above N	Below K	Above K	Above F	Control	Control
	B06N41	B06N42	B06N43	B06N44	B06N45	B06N46	B06N47	B06N48
Aluminum	25.10 U	19.50 U	21.90 U	21.10 U	18.10 U	20.50 U	21.10 U	15.90 U
Antimony	13.20 U	10.20 U	11.50 U	11.00 U	10.50 U	10.80 U	12.70 U	8.30 U
Arsenic	7.50 J	2.90 U	4.00 U	3.50 U	2.70 UJ	2.10 UJ	2.10 U	1.70 U
Barium	8.00 B	4.70 U	5.20 U	5.00 U	5.80 B	4.90 U	5.00 U	6.10 B
Beryllium	1.20 U	0.93 U	1.00 U	1.00 U	0.86 U	0.98 U	1.00 U	0.76 U
Cadmium	2.60 U	1.50 U	1.00 U	1.00 U	1.40 U	3.40 U	1.00 U	0.76 U
Calcium	1500.00 B	1810.00 B	1430.00 B	2010.00 B	2000.00 B	1410.00 B	1130.00 B	1610.00 B
Chromium	6.00 U	4.70 U	5.20 U	5.00 U	4.30 U	4.90 U	5.00 U	3.80 U
Cobalt	2.40 U	1.90 U	2.10 U	2.00 U	1.70 U	2.00 U	2.00 U	1.50 U
Copper	12.20 B	8.80 B	9.00 B	14.20 B	9.50 B	10.00 B	10.30 B	5.40 U
Iron	85.60 B	39.60 B	60.00 B	42.20 B	36.70 B	37.10 B	28.90 B	29.00 B
Lead	1.90 B	1.00 J	1.40 B	1.40 J	1.90 B	1.80 J	1.20 B	1.20 J
Magnesium	810.00 B	863.00 B	838.00 B	920.00 B	892.00 B	767.00 B	788.00 B	682.00 B
Manganese	12.90 B	8.20 B	6.60 B	9.80 B	9.10 B	11.20 B	10.30 B	5.50 B
Mercury	0.53 UJ	0.42 UJ	0.58 UJ	0.48 UJ	0.44 UJ	0.43 UJ	1.50 J	0.37 J
Nickel	6.00 U	4.70 U	5.20 U	5.50 B	4.30 U	4.90 U	5.00 U	3.80 U
Potassium	26600.00	22100.00	21100.00	20400.00	20400.00	19100.00	20800.00	19500.00
Selenium	4.80 J	3.40 UJ	4.10 UJ	4.30 U	3.70 UJ	4.10 J	3.90 U	3.00 U
Silver	3.60 U	2.80 U	3.10 U	3.00 U	2.60 U	2.90 U	3.00 U	2.30 U
Sodium	186.00 B	143.00 B	124.00 B	183.00 B	147.00 B	140.00 B	189.00 B	134.00 B
Thallium	1.10 UJ	0.85 UJ	1.00 UJ	5.40 UJ	0.93 UJ	0.91 UJ	0.99 UJ	0.74 UJ
Vanadium	2.40 U	1.90 U	2.10 U	2.00 U	1.70 U	2.00 U	2.00 U	1.50 U
Zinc	97.20	95.00	73.40	69.30	59.20	97.40	62.40	61.10
Cyanide	NR	NR	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U	U	U
Sr-90	0.048	0.330	-0.280	-0.130	0.150	-0.024	0.001	-0.043

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table B-3. Milfoil Results Collected at N Springs in 1992.

Constituent	Sample Identification Numbers and Sample Locations			
	B07921	B07922	B07923	Control B07924
Aluminum	6860.00	2760.00	3740.00	987.00
Antimony	9.20 U	5.20 U	5.40 U	19.60 U
Arsenic	6.30	2.90 B	4.00	3.80 UJ
Barium	147.00	104.00	122.00	114.00 B
Beryllium	0.64 U	0.12 U	0.38 U	0.63 U
Cadmium	4.60	4.30	4.60	5.50 B
Calcium	21100.00 J	21700.00 J	20500.00 J	26200.00 J
Chromium	16.20	5.40	8.20	7.00 B
Cobalt	5.20 B	2.00 B	3.10 B	3.10 U
Copper	61.10	24.90	35.70	26.00 B
Iron	12200.00	4190.00	6400.00	1780.00
Lead	28.30	11.60	17.70	9.80
Magnesium	6050.00 J	3390.00 J	3620.00 J	2650.00 J
Manganese	1190.00	402.00	771.00	370.00
Mercury	0.45	0.16	0.27	0.47 B
Nickel	16.40 B	6.20 B	9.30 B	9.00 B
Potassium	7840.00	1110.00 B	4500.00	2570.00 B
Selenium	2.10 U	1.40 U	1.20 U	4.60 U
Silver	1.40 U	0.77 U	0.81 U	2.90 U
Sodium	2900.00 J	464.00 J	1910.00 J	1190.00 J
Thallium	2.10 U	1.20 UJ	1.20 UJ	4.50 UJ
Vanadium	20.20 B	9.20 B	11.80 B	5.40 B
Zinc	319.00 J	189.00 J	230.00 J	206.00 J
Cyanide	NR	NR	NR	NR
Cs-137	U	U	0.19	U
Sr-90	0.18 R	-0.16 R	0.61	-0.04

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

APPENDIX C

ANALYTICAL RESULTS FOR REED CANARYGRASS

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Table C-1. Reed Canarygrass Sample Results from 100-F Reactor Area Collected Downriver in 1991.

Constituent	Sample Identification Numbers					
	B00VZ1	B00VZ2	B00VZ3	B00VZ4	B00VZ5	B00VZ6
Aluminum	704.00 J	456.00 J	548.00 J	1650.00 J	691.00 J	301.00 J
Antimony	6.80 UJ	6.60 UJ	6.50 UJ	6.40 UJ	6.70 UJ	6.30 UJ
Arsenic	0.89 UJ	0.75 UJ	0.77 UJ	1.40 UJ	0.52 UJ	0.41 UJ
Barium	25.90 J	19.60 J	18.00 J	44.50 J	21.50 J	21.30 J
Beryllium	0.22 UJ	0.21 UJ	0.21 UJ	0.21 UJ	0.22 UJ	0.20 UJ
Cadmium	0.53 UJ	0.58 UJ	0.33 UJ	0.88 UJ	0.37 UJ	0.37 UJ
Calcium	3880.00 J	3020.00 J	3160.00 J	5840.00 J	3520.00 J	3360.00 J
Chromium	3.00 UJ	2.10 UJ	2.70 UJ	5.10 J	2.90 UJ	4.00 UJ
Cobalt	0.65 J	0.63 UJ	0.63 UJ	2.00 J	0.65 J	0.61 UJ
Copper	10.50 J	9.10 J	10.70 J	18.60 J	7.50 UJ	9.20 UJ
Iron	1230.00 J	774.00 J	994.00 J	2910.00 J	1220.00 J	609.00 J
Lead	0.27 UJ	0.59 UJ	0.40 UJ	0.37 UJ	0.22 UJ	0.38 UJ
Magnesium	1900.00 J	1410.00 J	1790.00 J	3240.00 J	1620.00 J	1690.00 J
Manganese	125.00 J	85.50 J	77.50 J	199.00 J	113.00 J	65.10 J
Mercury	0.09 UJ	0.10 UJ	0.10 UJ	0.09 UJ	0.09 UJ	0.10 UJ
Nickel	2.10 J	1.00 J	1.20 J	5.20 J	2.10 J	0.92 J
Potassium	18400.00 J	16500.00 J	23300.00 J	24900.00 J	12600.00 J	20600.00 J
Selenium	0.85 UJ	4.10 UJ	4.20 UJ	4.30 UJ	0.87 UJ	0.83 UJ
Silver	1.10 UJ	1.10 UJ	1.10 UJ	1.00 UJ	1.10 UJ	1.00 UJ
Sodium	172.00 J	147.00 J	155.00 J	369.00 J	197.00 J	62.50 U
Thallium	0.43 UJ	0.41 UJ	0.42 UJ	0.43 UJ	0.43 UJ	0.41 UJ
Vanadium	2.50 J	1.50 J	1.80 J	5.50 J	2.40 J	0.98 J
Zinc	64.30 J	96.00 J	155.00 J	140.00 J	70.40 J	89.30 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<.5132 UJ	0.76 J	<1.270 UJ	<1.126 UJ	0.85 J	<1.078 UJ
Sr-90	-0.40 UJ	0.05 UJ	-0.04 UJ	-0.03 UJ	-0.04 UJ	-0.06 UJ
Tc-99	0.20 UJ	0.40 UJ	0.30 UJ	0.50 J	0.30 R	0.30 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-2. Reed Canarygrass Sample Results from 100-H Reactor Area Collected Upriver in 1991.

Constituent	Sample Identification Numbers					
	B00VX5	B00VX6	B00VX7	B00VX8	B00VX9	B00VY0
Aluminum	11.60 UJ	556.00 J	12.90 UJ	8.40 UJ	25.10 UJ	18.30 UJ
Antimony	1.60 UJ	1.60 UJ	1.70 UJ	1.60 UJ	1.60 UJ	1.70 UJ
Arsenic	0.88 J	0.90 J	0.58 J	0.40 UJ	0.43 UJ	0.43 UJ
Barium	35.70 J	23.90 J	14.60 J	21.00 J	34.60 J	20.60 J
Beryllium	0.21 UJ	0.20 UJ	0.21 UJ	0.20 UJ	0.21 UJ	0.21 UJ
Cadmium	0.21 UJ	0.35 UJ	0.21 UJ	0.20 UJ	0.21 UJ	0.21 UJ
Calcium	3330.00 J	4960.00 J	3010.00 J	3620.00 J	5790.00 J	3510.00 J
Chromium	0.82 UJ	2.30 J	0.86 UJ	0.81 UJ	1.30 J	1.60 J
Cobalt	0.62 UJ	0.94 UJ	0.64 UJ	0.61 UJ	0.62 UJ	0.64 UJ
Copper	5.80 UJ	12.70 J	3.80 UJ	5.10 UJ	5.20 UJ	6.10 UJ
Iron	44.20 J	986.00 J	30.20 J	37.60 J	69.90 J	62.00 J
Lead	0.43 UJ	2.20 J	0.43 UJ	0.40 UJ	0.43 UJ	2.10 UJ
Magnesium	1360.00 J	2720.00 J	1630.00 J	1660.00 J	1770.00 J	1830.00 J
Manganese	13.20 J	69.20 J	10.40 J	27.50 J	14.20 J	13.20 J
Mercury	0.09 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.11 UJ	0.10 UJ
Nickel	0.82 UJ	2.30 UJ	1.60 UJ	1.20 UJ	0.82 UJ	0.94 UJ
Potassium	18300.00 J	20000.00 J	12800.00 UJ	18600.00 J	16900.00 J	18800.00 J
Selenium	0.86 UJ	0.81 UJ	0.86 UJ	0.81 UJ	0.86 UJ	0.86 UJ
Silver	0.41 UJ	0.40 UJ	0.43 UJ	0.40 UJ	0.41 UJ	0.43 UJ
Sodium	64.90 J	101.00 J	37.60 UJ	79.40 J	47.00 J	22.40 UJ
Thallium	3.20 R	3.00 R	3.20 R	3.00 R	3.20 R	3.20 R
Vanadium	0.41 UJ	1.50 J	0.43 UJ	0.40 UJ	0.41 UJ	0.43 UJ
Zinc	96.80 J	186.00 J	89.80 J	97.30 J	84.40 J	89.30 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<1.063 UJ	<1.630 UJ	<1.020 UJ	<.865 UJ	<.9501 UJ	<1.456 UJ
Sr-90	-0.05 UJ	-0.3 UJ	-0.70 UJ	0.05 UJ	0.09 UJ	0.03 UJ
Tc-99	0.20 R	0.20 UJ	0.30 UJ	0.20 R	0.50 R	0.20 R

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-3. Reed Canarygrass Sample Results from 100-H Reactor Area Collected Downriver in 1991.

Constituent	Sample Identification Numbers					
	B00VY3	B00VY4	B00VY5	B00VY6	B00VY7	B00VY8
Aluminum	10.20 UJ	7.90 UJ	883.00 J	843.00 J	3020.00 J	315.00 J
Antimony	1.80 UJ	1.70 UJ	1.70 UJ	1.70 UJ	1.70 UJ	1.70 UJ
Arsenic	0.94 J	0.88 J	1.30 J	1.30 J	3.50 J	0.84 J
Barium	10.00 J	13.20 J	33.80 J	23.10 J	52.10 J	26.20 J
Beryllium	0.22 UJ	0.22 UJ	0.21 UJ	0.22 UJ	0.21 UJ	0.21 UJ
Cadmium	0.22 UJ	0.22 UJ	0.89 UJ	0.54 UJ	0.94 UJ	0.24 UJ
Calcium	2560.00 J	2110.00 J	4330.00 J	3690.00 J	4970.00 J	4290.00 J
Chromium	0.88 UJ	0.87 UJ	3.30 J	3.70 J	8.70 J	1.70 J
Cobalt	0.66 UJ	0.66 UJ	0.97 UJ	0.88 J	2.80 UJ	0.73 UJ
Copper	9.20 J	6.00 UJ	15.10 J	12.40 J	25.00 J	8.50 J
Iron	32.30 J	20.00 UJ	1530.00 J	1380.00 J	4920.00 J	549.00 J
Lead	0.43 UJ	0.42 UJ	4.40 J	2.30 J	11.10 J	0.57 J
Magnesium	1340.00 J	1420.00 J	2350.00 J	1740.00 J	3440.00 J	2600.00 J
Manganese	21.70 J	22.50 J	107.00 J	80.00 J	254.00 J	70.10 J
Mercury	0.10 UJ	0.11 UJ	0.09 UJ	0.10 UJ	0.10 UJ	0.10 UJ
Nickel	0.88 UJ	0.87 UJ	3.30 UJ	2.70 UJ	9.30 J	1.70 UJ
Potassium	18000.00 J	16000.00 J	24000.00 J	19600.00 J	23800.00 J	15900.00 J
Selenium	0.86 UJ	0.84 UJ	4.30 UJ	0.87 UJ	4.10 UJ	0.85 UJ
Silver	0.44 UJ	0.44 UJ	0.42 UJ	0.43 UJ	0.42 UJ	0.42 UJ
Sodium	31.90 UJ	34.40 UJ	342.00 J	233.00 J	320.00 J	49.60 J
Thallium	3.20 R	3.20 R	3.20 R	3.30 R	3.00 R	3.20 R
Vanadium	0.44 UJ	0.44 UJ	2.10 J	2.60 J	9.00 J	0.63 J
Zinc	39.10 J	55.10 J	131.00 J	78.40 J	271.00 J	83.80 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<1.140 UJ	<.7542 UJ	0.80 J	1.489 UJ	<1.648 UJ	<.8158 UJ
Sr-90	-0.20 UJ	0.20 UJ	0.00 UJ	-0.20 UJ	-0.07 UJ	-0.09 UJ
Tc-99	0.20 UJ	0.40 UJ	0.50 J	0.60 J	0.30 UJ	0.50 R

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-4. Reed Canarygrass Sample Results from 100-D Reactor Area Collected in 1991.

Constituent	Sample Identification Numbers					
	B00VV9	B00VW0	B00VW1	B00VW2	B00VW3	B00VW4
Aluminum	17.50 UJ	53.00 J	14.30 UJ	27.20 J	13.40 UJ	18.00 J
Antimony	1.60 UJ	1.70 UJ	6.70 UJ	6.90 UJ	6.30 UJ	6.60 UJ
Arsenic	0.43 UJ	0.41 UJ	2.10 UJ	0.49 J	0.44 UJ	0.43 UJ
Barium	17.70 J	23.50 J	21.40 J	28.40 J	23.00 J	28.00 J
Beryllium	0.20 UJ	0.21 UJ	0.22 UJ	0.22 UJ	0.20 UJ	0.21 UJ
Cadmium	0.20 UJ	0.21 UJ	0.22 UJ	0.27 J	0.20 UJ	0.21 UJ
Calcium	2580.00 J	5880.00 J	4480.00 J	5670.00 J	5210.00 J	5360.00 J
Chromium	0.82 UJ	1.00 J	0.81 J	1.30 J	1.40 J	1.60 J
Cobalt	0.61 UJ	0.63 UJ	0.65 UJ	0.67 UJ	0.61 UJ	0.64 UJ
Copper	3.10 U	4.50 U	9.00 J	4.80 J	4.40 UJ	5.90 J
Iron	54.50 J	119.00 J	56.40 J	80.50 J	46.80 J	82.90 J
Lead	0.43 UJ	0.41 UJ	0.43 UJ	0.44 UJ	0.44 UJ	0.43 UJ
Magnesium	1470.00 J	2080.00 J	2390.00 J	2220.00 J	2530.00 J	2600.00 J
Manganese	18.60 J	26.20 J	19.50 J	16.90 J	13.30 J	10.50 J
Mercury	0.11 UJ	0.10 UJ	0.11 UJ	0.11 UJ	0.10 UJ	0.11 UJ
Nickel	0.82 UJ	1.20 UJ	0.87 UJ	0.89 UJ	0.81 UJ	0.85 UJ
Potassium	15400.00 J	15300.00 J	26000.00 J	15500.00 J	12900.00 J	21100.00
Selenium	0.86 UJ	0.83 UJ	4.30 UJ	0.87 UJ	0.87 UJ	0.86 UJ
Silver	0.41 UJ	0.42 UJ	1.10 UJ	1.10 UJ	1.00 UJ	1.10 UJ
Sodium	43.70 UJ	45.30 UJ	40.80 J	42.10 J	41.60 J	39.60 J
Thallium	3.20 R	3.10 R	3.20 UJ	3.30 UJ	3.30 UJ	3.20 UJ
Vanadium	0.41 UJ	0.42 UJ	0.65 UJ	0.67 UJ	0.61 UJ	0.64 UJ
Zinc	64.90 J	64.20 J	60.20 J	36.90 J	90.30 J	68.80 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<1.087 UJ	<1.199 UJ	<.748 UJ	<1.504 UJ	<.909 UJ	<1.064 UJ
Sr-90	-0.40 UJ	0.00 UJ	0.00 UJ	-0.50 UJ	0.00 UJ	-0.05 UJ
Tc-99	0.20 UJ	0.30 J	0.20 J	0.20 UJ	0.16 J	0.40 J

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-5. Reed Canarygrass Duplicate Sample Results from 100-D Reactor Area Collected in 1991.

Constituent	Sample Identification Numbers					
	B01047	B01048	B01049	B01050	B01051	B01052
Aluminum	26.40 J	19.70 J	15.00 UJ	13.90 J	13.40 UJ	13.30 UJ
Antimony	6.50 UJ	7.30 UJ	7.00 UJ	6.40 UJ	6.30 UJ	6.20 UJ
Arsenic	0.41 UJ	0.46 UJ	0.47 UJ	0.43 UJ	0.48 UJ	0.40 UJ
Barium	22.10 J	33.50 J	21.00 J	14.50 J	19.60 J	31.50 J
Beryllium	0.21 UJ	0.24 UJ	0.23 UJ	0.21 UJ	0.20 UJ	0.20 UJ
Cadmium	0.21 UJ	0.24 UJ	0.23 UJ	0.21 UJ	0.20 UJ	0.25 UJ
Calcium	3570.00 J	6230.00 J	3370.00 J	2940.00 J	4900.00 J	5800.00 J
Chromium	0.68 J	1.00 J	0.64 J	0.41 UJ	1.30 UJ	1.70 UJ
Cobalt	0.62 UJ	0.71 UJ	0.68 UJ	0.62 UJ	0.61 UJ	0.60 UJ
Copper	3.20 J	3.30 J	3.60 J	2.90 J	8.50 UJ	6.70 UJ
Iron	70.00 J	47.70 J	35.60 J	34.40 J	42.00 J	40.30 J
Lead	0.41 UJ	0.46 UJ	0.47 UJ	0.43 UJ	0.37 UJ	0.68 UJ
Magnesium	1670.00 J	2230.00 J	1260.00 J	1410.00 J	2710.00 J	2810.00 J
Manganese	29.90 J	16.50 J	12.50 J	13.20 J	17.10 J	15.30 J
Mercury	0.10 UJ	0.10 UJ	0.11 UJ	0.11 UJ	0.10 UJ	0.10 UJ
Nickel	0.83 UJ	0.95 UJ	0.91 UJ	1.20 J	0.81 UJ	1.10 J
Potassium	18300.00 J	16700.00 J	21100.00 J	14800.00 J	19300.00 J	18500.00 J
Selenium	0.82 UJ	0.92 UJ	0.93 UJ	0.87 UJ	4.20 UJ	0.80 UJ
Silver	1.00 UJ	1.20 UJ	1.10 UJ	1.00 UJ	1.00 UJ	1.00 UJ
Sodium	40.80 J	25.00 J	38.10 J	14.50 J	25.70 UJ	32.70 UJ
Thallium	3.10 UJ	3.50 UJ	3.50 UJ	3.30 UJ	0.42 UJ	0.40 UJ
Vanadium	0.62 UJ	0.71 UJ	0.68 UJ	0.62 UJ	0.61 UJ	0.60 UJ
Zinc	34.60 J	168.00 J	133.00 J	85.20 J	90.50 J	87.20 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<.7619 UJ	<1.315 UJ	<.9526 UJ	<.6895 UJ	<1.195 UJ	<.6638 UJ
Sr-90	-2.00 UJ	0.10 J	-1.00 UJ	-0.2 UJ	0.60 J	-0.90 UJ
Tc-99	0.13 J	0.30 J	0.30 R	0.76 J	0.20 UJ	0.20 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-6. Reed Canarygrass Sample Results Collected Below 100-D Reactor in 1991.

Constituent	Sample Identification Numbers					
	B00VW7	B00VW8	B00VW9	B00VX0	B00VX1	B00VX2
Aluminum	19.90 UJ	193.00 J	27.90 UJ	165.00 J	36.10 J	168.00 J
Antimony	1.60 UJ	1.60 UJ	1.90 UJ	1.70 UJ	1.70 UJ	1.70 UJ
Arsenic	0.44 J	0.51 J	0.49 UJ	0.56 J	0.43 UJ	0.41 UJ
Barium	10.20 J	19.50 J	14.60 J	14.10 J	11.60 J	20.90 J
Beryllium	0.20 UJ	0.21 UJ	0.23 UJ	0.21 UJ	0.21 UJ	0.21 UJ
Cadmium	0.20 UJ	0.21 UJ	0.23 UJ	0.29 UJ	0.21 UJ	0.21 UJ
Calcium	2450.00 J	3450.00 J	3150.00 J	3180.00 J	4030.00 J	4860.00 J
Chromium	0.82 UJ	0.82 UJ	0.93 UJ	1.50 J	1.50 J	1.80 J
Cobalt	0.61 UJ	1.20 UJ	0.69 UJ	0.98 UJ	0.63 UJ	0.64 UJ
Copper	3.30 UJ	7.90 J	6.70 UJ	5.80 UJ	3.40 UJ	5.40 UJ
Iron	46.70 J	355.00 J	66.70 J	286.00 J	82.10 J	285.00 J
Lead	2.20 UJ	0.61 J	2.40 UJ	0.56 J	0.43 UJ	0.41 UJ
Magnesium	1230.00 J	1970.00 J	1650.00 J	1440.00 J	1750.00 J	2350.00 J
Manganese	17.90 J	80.50 J	36.60 J	36.60 J	23.60 J	44.70 J
Mercury	0.09 UJ	0.10 UJ	0.11 UJ	0.09 UJ	0.10 UJ	0.10 UJ
Nickel	0.82 UJ	1.80 UJ	0.93 UJ	1.60 UJ	0.84 UJ	0.85 UJ
Potassium	13500.00 J	19200.00 J	12800.00 J	12100.00 J	13500.00 J	16800.00 J
Selenium	0.87 UJ	0.88 UJ	0.97 UJ	0.86 UJ	0.86 UJ	0.82 UJ
Silver	0.41 UJ	0.41 UJ	0.46 UJ	0.42 UJ	0.42 UJ	0.42 UJ
Sodium	42.80 UJ	70.80 J	102.00 J	96.30 J	80.80 J	57.90 J
Thallium	3.30 R	3.30 R	3.60 R	3.20 R	3.20 R	3.10 R
Vanadium	0.41 UJ	0.41 UJ	0.46 UJ	0.42 UJ	0.42 UJ	0.42 UJ
Zinc	24.00 J	58.60 J	28.10 J	35.80 J	20.90 J	44.80 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<.9632 J	<1.974 UJ	<1.079 UJ	<1.187 UJ	<.9326 UJ	<1.737 UJ
Sr-90	0.08 UJ	-0.40 UJ	-0.10 UJ	0.00 UJ	-0.03 UJ	-0.30 UJ
Tc-99	-0.10 R	0.30 R	0.90 R	0.20 UJ	0.40 J	0.20 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-7. Reed Canarygrass Sample Results from 100-BC Reactor Area Collected Downriver in 1991.

Constituent	Sample Identification Numbers					
	B00VV1	B00VV2	B00VV3	B00VV4	B00VV5	B00VV6
Aluminum	189.00 J	240.00 J	206.00 J	447.00 J	195.00 J	29.20 J
Antimony	6.60 UJ	6.30 UJ	6.40 UJ	6.40 UJ	6.20 UJ	6.60 UJ
Arsenic	1.10 UJ	0.88 UJ	0.59 UJ	0.40 UJ	0.66 UJ	0.57 UJ
Barium	18.10 J	35.60 J	16.50 J	34.10 J	40.30 J	24.20 J
Beryllium	0.21 UJ	0.20 UJ	0.21 UJ	0.20 UJ	0.20 UJ	0.21 UJ
Cadmium	0.21 UJ	0.20 UJ	0.21 UJ	0.20 UJ	0.20 UJ	0.21 UJ
Calcium	4060.00 J	6190.00 J	3140.00 J	4840.00 J	4200.00 J	4180.00 J
Chromium	1.60 UJ	1.40 UJ	1.70 UJ	1.80 U	1.80 UJ	0.89 UJ
Cobalt	0.64 UJ	0.61 UJ	0.62 UJ	0.72 J	0.60 UJ	0.64 UJ
Copper	6.90 UJ	8.10 UJ	9.10 UJ	9.60 U	6.80 UJ	4.90 UJ
Iron	351.00 J	421.00 J	415.00 J	842.00 J	380.00 J	84.20 J
Lead	1.10 UJ	0.86 UJ	1.40 J	1.70 J	1.00 UJ	0.21 UJ
Magnesium	2190.00 J	3190.00 J	1760.00 J	2130.00 J	1570.00 J	1880.00 J
Manganese	49.00 J	76.20 J	79.90 J	83.20 J	33.60 J	40.90 J
Mercury	0.36 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ
Nickel	0.85 UJ	1.50 J	0.82 UJ	1.50 J	0.83 J	0.86 UJ
Potassium	14700.00 J	18800.00 J	21700.00 J	17600.00 J	15400.00 J	15800.00 J
Selenium	0.87 UJ	0.82 UJ	4.20 UJ	0.80 UJ	4.20 UJ	0.85 UJ
Silver	1.10 UJ	1.00 UJ	1.00 UJ	1.00 UJ	0.99 UJ	1.10 UJ
Sodium	40.40 UJ	70.80 UJ	95.40 J	112.00 J	39.20 UJ	17.50 UJ
Thallium	0.43 UJ	0.41 UJ	0.42 UJ	0.40 UJ	0.42 UJ	0.42 UJ
Vanadium	0.64 UJ	1.10 J	0.98 J	1.60 J	0.85 J	0.64 UJ
Zinc	50.00 J	54.70 J	101.00 J	87.90 J	41.00 J	63.70 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<1.432 UJ	<1.459 UJ	<1.121 UJ	<.863 UJ	<1.204 UJ	<.6650 UJ
Sr-90	-2.00 UJ	0.01 UJ	0.06 UJ	0.20 UJ	0.06 UJ	-0.50 UJ
Tc-99	0.30 J	0.40 J	0.10 UJ	0.10 UJ	0.10 UJ	0.20 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-8. Reed Canarygrass Control Sample Results from 1991.

Constituent	Sample Identification Numbers					
	B00VT3	B00VT4	B00VT5	B00VT6	B00VT7	B00VT8
Aluminum	1290.00 J	480.00 J	1950.00 J	3260.00 J	779.00 J	847.00 J
Antimony	6.70 UJ	6.60 UJ	6.30 UJ	6.50 UJ	6.20 UJ	6.60 UJ
Arsenic	0.93 UJ	0.93 UJ	3.00 UJ	4.20 UJ	0.84 UJ	1.30 UJ
Barium	42.70 J	21.60 J	48.20 J	55.90 J	30.90 J	31.20 J
Beryllium	0.21 UJ	0.21 UJ	0.20 UJ	0.21 UJ	0.20 UJ	0.21 UJ
Cadmium	0.54 UJ	0.21 UJ	0.74 UJ	0.87 U	0.41 UJ	0.42 UJ
Calcium	5650.00 J	4050.00 J	5300.00 J	6320.00 J	5620.00 J	5150.00 J
Chromium	4.50 J	2.20 UJ	5.40 J	8.70 J	3.20 UJ	3.40 UJ
Cobalt	0.64 UJ	0.64 UJ	1.30 J	2.60 J	0.60 J	0.64 UJ
Copper	13.30 J	10.90 J	14.80 J	19.90 J	12.40 J	15.10 J
Iron	2190.00 J	903.00 J	3330.00 J	5550.00 J	1360.00 J	1520.00 J
Lead	3.60 J	2.40 J	6.80 J	0.40 UJ	0.29 UJ	1.40 J
Magnesium	2330.00 J	2110.00 J	4260.00 J	4430.00 J	2680.00 J	3470.00 J
Manganese	107.00 J	68.00 J	135.00 J	256.00 J	70.30 J	79.20 J
Mercury	0.10 UJ	0.10 UJ	0.10 UJ	1.10 UJ	0.09 UJ	0.10 UJ
Nickel	3.90 J	1.50 J	4.90 J	9.10 J	2.10 J	2.70 J
Potassium	14900.00 J	16300.00 J	26400.00 J	24300.00 J	22200.00 J	30700.00 J
Selenium	4.20 UJ	0.86 UJ	0.81 UJ	4.20 UJ	4.00 UJ	0.83 UJ
Silver	1.10 UJ	1.10 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.10 UJ
Sodium	160.00 J	82.50 J	537.00 J	605.00 J	127.00 J	301.00 J
Thallium	0.42 UJ	0.43 UJ	0.41 UJ	0.42 UJ	0.40 UJ	0.41 UJ
Vanadium	3.80 J	1.60 J	5.80 J	10.20 J	2.70 J	2.60 J
Zinc	90.20 J	70.70 J	97.70 J	135.00 J	114.00 J	136.00 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	<.954 UJ	<1.804 UJ	<1.138 UJ	<.896 UJ	<1.463 UJ	<1.63 UJ
Sr-90	0.09 UJ	0.01 UJ	0.04 UJ	0.80 UJ	-0.50 UJ	0.01 UJ
Tc-99	0.20 UJ	0.30 UJ	0.30 J	0.10 UJ	0.30 UJ	0.10 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-9. Reed Canarygrass Sample Results from 100-F Reactor Area Collected Downriver and Upriver in 1992.

Constituent	Sample Identification Numbers					
	B06N63	B06N64	B06N65	B06N66	B06N67	B06N68
Aluminum	142.00	252.00	46.50 B	189.00	339.00	608.00
Antimony	5.90 U	4.20 U	5.60 U	7.20 U	4.30 U	4.70 U
Arsenic	1.00 U	0.72 U	0.96 U	1.10 U	0.90 B	1.00 B
Barium	22.00 B	19.60 B	16.50 B	26.50 B	23.90 B	23.10 B
Beryllium	0.14 U	0.10 U	0.13 U	0.17 U	0.10 U	0.54 U
Cadmium	0.35 U	0.25 U	0.33 U	0.42 U	0.26 U	0.32 U
Calcium	3530.00	3890.00	3780.00	6950.00	4190.00	4340.00
Chromium	2.10 B	1.70 B	1.50 U	2.30 B	1.20 U	2.10 B
Cobalt	0.94 U	0.68 U	0.90 U	1.10 U	0.69 U	0.92 B
Copper	5.80 B	5.70 B	4.00 B	7.60 B	3.70 B	6.30 B
Iron	258.00	436.00	109.00	355.00	593.00	1070.00
Lead	3.80 J	1.50 J	0.72 J	2.00 J	4.20 J	4.50 J
Magnesium	1710.00 B	2020.00	2310.00	3020.00	2620.00	2200.00
Manganese	35.60	88.70	48.90	53.20	42.80	72.50
Mercury	0.08 U	0.06 U	0.08 U	0.09 U	0.06 U	0.08 B
Nickel	1.90 U	1.40 U	1.80 U	2.30 U	1.90 B	2.10 B
Potassium	9110.00	9020.00	18000.00	21000.00	12900.00	10300.00
Selenium	1.30 UJ	0.95 UJ	1.30	1.50	0.94 U	1.00 U
Silver	0.87 U	0.62 U	0.83 U	1.10 U	0.64 U	0.70 U
Sodium	98.80 J	153.00 J	144.00 J	492.00 J	75.20 J	256.00 J
Thallium	0.45 UJ	0.32 UJ	0.43 UJ	0.51 UJ	0.32 UJ	0.36 UJ
Vanadium	0.97 U	1.10 B	0.93 U	1.20 U	1.30 B	1.80 B
Zinc	36.80 J	65.40 J	33.60 J	69.80 J	43.00 J	56.10 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U
Sr-90	-0.20	0.20	0.06	2.40	2.90	0.02

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-10. Reed Canarygrass Sample Results from 100-H Reactor Area Collected Downriver and Upriver in 1992.

Constituent	Sample Identification Numbers					
	B06N69	B06N70	B06N71	B06N72	B06N73	B06N74
Aluminum	50.50 B	110.00	38.80 B	23.10 U	50.00 B	199.00
Antimony	5.50 U	3.90 U	4.20 U	4.00 U	4.70 U	3.90 U
Arsenic	0.97 U	0.68 U	0.69 U	0.69 U	0.80 U	0.68 U
Barium	33.20 B	23.20 B	17.90 B	19.80 B	22.60 B	12.60 B
Beryllium	0.13 U	0.09 U	0.19 U	0.10 U	0.11 U	0.09 U
Cadmium	0.32 U	0.23 U	0.25 U	0.24 U	0.28 U	0.23 U
Calcium	7590.00	6130.00	4340.00	5950.00	5380.00	1970.00
Chromium	1.50 U	2.30	1.20 B	2.70	1.30 U	1.10 B
Cobalt	0.87 U	0.62 U	0.67 U	0.64 U	0.76 U	0.63 U
Copper	3.80 B	3.50 B	3.00 B	3.40 B	5.40 B	4.70 B
Iron	116.00	207.00	81.40	61.10	98.10	353.00
Lead	0.67 UJ	0.89 J	0.48 UJ	0.48 J	1.70 J	1.80 J
Magnesium	3320.00	3660.00	2220.00	2650.00	2770.00	1190.00
Manganese	45.30	24.80	39.40	11.30	11.10	37.30
Mercury	0.08 U	0.06 U	0.06 U	0.06 U	0.14	0.10 B
Nickel	1.70 U	1.20 U	1.30 U	1.30 U	1.50 U	1.30 U
Potassium	12400.00	12100.00	15100.00	10700.00	14200.00	9900.00
Selenium	1.30 U	2.30 U	0.91 U	0.90 U	1.00 U	0.89 UJ
Silver	0.81 U	0.57 U	0.62 U	0.59 U	0.70 U	0.58 U
Sodium	69.00 J	98.10 J	35.60 U	38.40 U	54.40 U	47.20 U
Thallium	0.44 UJ	0.30 UJ	0.31 UJ	0.31 UJ	0.36 UJ	0.30 J
Vanadium	0.90 U	0.64 U	0.70 U	0.66 U	0.79 U	0.79 B
Zinc	70.10 J	64.70 J	38.00 J	74.80 J	305.00 J	95.80 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U
Sr-90	0.081	0.096	0.000	0.062	-0.630	0.140

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-11. Reed Canarygrass Sample Results from 100-D Reactor Area Collected Downriver and Upriver in 1992.

Constituent	Sample Identification Numbers						
	B06N75	B06N76	B06N77	B06N78	B06N79	B06N80	Control B06N81
Aluminum	180.00 J	118.00	60.80	273.00	273.00	535.00	207.00
Antimony	4.40 U	4.50 U	5.10 U	4.20 U	4.50 U	3.80 U	3.90 U
Arsenic	0.98 B	1.00 B	0.85 UJ	0.97 B	0.75 U	0.66 UJ	0.68 U
Barium	35.30 B	14.30 B	27.20 B	21.70 B	17.50 B	21.90 B	14.80 B
Beryllium	0.10 U	0.11 U	0.12 U	0.39 U	0.11 U	0.44 U	0.09 U
Cadmium	0.26 U	0.26 U	0.30 U	0.25 U	0.27 U	0.23 U	0.23 U
Calcium	7030.00	2520.00	4060.00	4680.00	4430.00	5070.00	3560.00
Chromium	1.40 B	1.20 U	1.30 U	2.50	1.20 U	1.40 B	1.60 B
Cobalt	0.70 U	0.71 U	0.81 U	0.70 B	0.72 U	0.62 U	0.63 U
Copper	4.00 B	3.30 B	3.40 B	4.90 B	5.00 B	5.10 B	4.40 B
Iron	382.00	231.00	128.00	491.00	514.00	907.00	426.00
Lead	2.30 J	1.00 J	0.68 J	2.70 J	0.91 J	3.80 J	1.20 J
Magnesium	2750.00	1680.00	2080.00	2050.00	1830.00	1800.00	1890.00
Manganese	58.50	51.20	39.90	84.40	64.80	55.10	58.10
Mercury	0.06 U	0.05 U	0.07 U	0.05 U	0.06 U	0.05 U	0.06 U
Nickel	1.40 U	1.40 U	1.60 U	2.30 B	1.40 U	1.60 B	1.30 U
Potassium	12700.00	12400.00	10100.00	9190.00	11200.00	7780.00	11800.00
Selenium	0.99 U	0.99 U	1.10 U	0.95 U	0.98 UJ	0.87 U	0.89 U
Silver	0.65 U	0.66 U	0.75 U	0.62 U	0.67 U	0.57 U	0.58 U
Sodium	94.60 J	59.20 J	147.00 J	103.00 J	150.00 J	218.00 J	139.00 J
Thallium	0.34 UJ	0.34 UJ	0.38 UJ	0.32 U	0.33 UJ	0.30 U	0.30 UJ
Vanadium	0.73 U	0.74 U	0.84 U	1.00 B	0.75 U	1.50 B	0.81 B
Zinc	70.50 J	59.40 J	143.00 J	91.10 J	47.30 J	51.80 J	69.60 J
Cyanide	NR	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U	U
Sr-90	.069	0.041	0.06	-0.28	-0.17	-0.36	0.009

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-12. Reed Canarygrass Sample Results from 100-K Reactor Area Collected Downriver and Upriver in 1992.

Constituent	Sample Identification Numbers					
	B06N82	B06N83	B06N84	B06N85	B06N86	B06N87
Aluminum	97.30	238.00	116.00	399.00	125.00	78.80
Antimony	4.00 U	4.20 U	4.30 U	4.30 U	3.30 U	4.00 U
Arsenic	0.77 J	1.10 J	0.98 J	1.50 J	1.10 J	0.90 J
Barium	12.80 B	23.20 B	14.20 B	16.90 B	16.60 B	20.20 B
Beryllium	0.10 U	0.10 U	0.10 U	0.10 U	0.08 U	0.09 U
Cadmium	0.24 U	0.37 U	0.38 U	0.38 U	0.38 U	1.50
Calcium	2920.00	5930.00 J	2860.00 J	3170.00 J	3750.00 J	2890.00 J
Chromium	1.10 U	1.10 U	1.10 U	1.10 U	0.89 U	1.10 U
Cobalt	0.64 U	0.67 U	0.69 U	0.69 U	0.53 U	0.64 U
Copper	4.60 B	6.50	6.50	7.80	8.60	4.10 U
Iron	199.00	511.00 J	250.00 J	720.00 J	260.00 J	159.00 J
Lead	1.10 J	3.40	1.40	4.30	3.20	1.00
Magnesium	1990.00	2100.00	1580.00	1910.00	2470.00	2390.00
Manganese	77.40	96.00 J	57.60	47.90 J	45.90 J	25.70 J
Mercury	0.06 U	0.05 UJ	0.10 J	0.06 J	0.05 UJ	0.05 UJ
Nickel	1.30 U	1.30 U	1.40 U	4.20 B	1.50 B	1.30 U
Potassium	14600.00	12400.00 J	12100.00 J	9920.00 J	12700.00 J	14300.00 J
Selenium	0.90 U	0.96 UJ	0.99 UJ	1.10 B	0.75 UJ	1.10 B
Silver	0.59 U	0.89 U	0.92 U	0.92 U	0.71 U	0.85 U
Sodium	129.00 J	91.90 U	38.70 U	85.30 U	84.40 U	33.80 U
Thallium	0.31 U	0.42 U	0.43 U	0.74 B	0.33 U	0.40 UJ
Vanadium	0.66 U	0.69 U	0.71 U	0.71 U	0.55 U	0.66 U
Zinc	97.40 J	75.30 J	147.00 J	192.00 J	112.00 J	128.00 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	U	U	0.23	U	U	U
Sr-90	-0.850	0.430 R	0.011 UJ	0.029 UJ	0.00 UJ	0.14 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table C-13. Reed Canarygrass Sample Results from 100-BC Reactor Area Collected Downriver and Upriver in 1992.

Constituent	Sample Identification Numbers						
	B06N88	B06N89	B06N90	B06N91	B06N92	B06N93	Control B06N94
Aluminum	120.00	99.60	78.30	190.00	113.00	132.00	101.00
Antimony	3.90 U	3.90 U	4.00 U	4.90 U	4.20 U	5.50 U	4.50 U
Arsenic	0.77 J	0.75 UJ	0.76 UJ	1.70 J	1.30 J	1.30 J	1.20 J
Barium	16.40 B	18.00 B	15.90 B	18.40 B	11.60 B	12.70 B	10.10 B
Beryllium	0.09 U	0.09 U	0.10 U	0.12 U	0.10 U	0.13 U	0.11 U
Cadmium	0.35 U	0.35 U	0.36 U	0.44 U	0.37 U	0.49 U	0.40 U
Calcium	5110.00 J	4750.00 J	5870.00 J	5950.00 J	3000.00 J	3310.00 J	2360.00 J
Chromium	1.00 U	1.00 U	1.10 U	1.30 U	1.10 U	1.50 U	1.20 U
Cobalt	0.62 U	0.62 U	0.64 U	0.79 U	0.67 U	0.88 U	0.72 U
Copper	2.70 U	3.30 U	2.80 U	2.20	3.00 U	2.50 U	2.90 U
Iron	232.00 J	208.00 J	167.00 J	350.00 J	227.00 J	249.00 J	198.00 J
Lead	1.60	1.80 J	0.83 J	1.80 J	1.60	1.70	1.60
Magnesium	2470.00	2020.00	3020.00	2350.00	2580.00	2130.00	1180.00 B
Manganese	63.30 J	47.10 J	77.10 J	57.20 J	74.70 J	63.40 J	22.00 J
Mercury	NR	0.05 UJ	0.06 UJ	0.07 UJ	0.05 UJ	0.08 UJ	0.07 UJ
Nickel	1.20 U	1.20 U	1.30 U	1.60 U	1.30 U	1.80 U	1.40 U
Potassium	10600.00 J	9170.00 J	11300.00 J	15500.00 J	9830.00 J	7460.00 J	7390.00 J
Selenium	0.94 U	0.92 U	0.92 U	1.10 U	1.30	1.30 UJ	1.10 UJ
Silver	0.83 U	0.83 U	0.85 U	1.10 U	0.90 U	1.20 U	0.96 U
Sodium	44.70 U	64.80 U	44.30 U	257.00 J	153.00 J	152.00 J	48.90 U
Thallium	0.41 U	0.46 B	0.40 U	0.49 UJ	0.43 UJ	0.56 U	0.47 U
Vanadium	0.65 U	0.65 U	0.66 U	0.82 U	0.70 U	0.92 U	0.75 U
Zinc	68.10 J	46.80 J	41.60 J	98.10 J	121.00 J	115.00 J	45.60 J
Cyanide	NR	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U	U
Sr-90	-0.10 UJ	-0.34 UJ	0.27 UJ	0.16 UJ	0.20 UJ	0.024 UJ	-0.29 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

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APPENDIX D

ANALYTICAL RESULTS FOR TREES

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Table D-1. Tree Leaf Sample Results Collected from 100 Areas in 1991.
(sheet 1 of 2)

Constituent	Sample Identification Numbers and Locations							
	Control	Control	Below D	Below D	Below D	Below D	Below D	Below D
	B00VT9	B00VV0	B00VW5[a] (B01053)	B00VW6[a] (B01054)	B01053 Duplicate	B01054 Duplicate	B00VX3	B00VX4
Aluminum	2780.00 J	352.00 J	744.00 J	281.00 J	354.00 J	301.00 J	433.00 J	499.00 J
Antimony	3.20 UJ	3.50 J	3.40 J	3.20 UJ	4.50 J	3.20 UJ	3.20 UJ	3.20 UJ
Arsenic	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ
Barium	214.00 J	125.00 J	136.00 J	168.00 J	151.00 J	117.00 J	199.00 J	129.00 J
Beryllium	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ
Cadmium	1.20 J	0.40 UJ	0.40 UJ	0.62 J	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ
Calcium	115000.00 J	121000.00 J	113000.00 J	97800.00 J	119000.00 J	118000.00 J	121000.00 J	121000.00 J
Chromium	6.80 J	2.10 J	1.30 J	1.70 J	2.00 J	1.80 J	4.50 J	2.80 J
Cobalt	2.00 J	0.96 J	0.60 UJ	1.20 J	0.96 J	1.10 J	0.64 J	1.10 J
Copper	39.80 J	19.70 J	23.40 J	34.00 J	24.70 J	34.40 J	27.40 J	24.80 J
Iron	3590.00 J	600.00 J	647.00 J	604.00 J	660.00 J	729.00 J	790.00 J	864.00 J
Lead	7.10 J	1.00 J	0.91 J	1.10 J	1.00 J	1.10 J	0.98 J	1.10 J
Magnesium	27900.00 J	26600.00 J	16600.00 J	12300.00 J	12800.00 J	23500.00 J	22500.00 J	25500.00 J
Manganese	176.00 J	61.30 J	198.00 J	125.00 J	125.00 J	280.00 J	98.00 J	85.10 J
Nickel	5.30 J	1.00 J	4.40 J	6.40 J	4.40 J	6.60 J	1.00 J	1.40 J
Potassium	66500.00 J	41400.00 J	87800.00 J	113000.00 J	89600.00 J	97000.00 J	93600.00 J	73400.00 J
Selenium	4.00 UJ	4.00 UJ	4.00 UJ	4.00 UJ	4.00 UJ	4.00 UJ	4.00 UJ	4.00 UJ
Silver	1.20 J	1.30 J	0.40 UJ	0.40 UJ	0.40 UJ	0.98 J	0.74 J	0.92 J
Sodium	1070.00 J	575.00 J	361.00 J	362.00 J	450.00 J	516.00 J	1020.00 J	1410.00 J
Thallium	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ
Vanadium	6.80 J	0.92 J	0.75 J	1.00 J	1.20 J	0.94 J	0.69 J	1.20 J
Zinc	241.00 J	118.00 J	142.00 J	195.00 J	143.00 J	160.00 J	220.00 J	247.00 J
Cyanide	NR	NR	NR	NR	NR	NR	NR	NR
Cs-137	<.2072 UJ	<.1545 UJ	<1.161 UJ	<.9875 UJ	<.6489 UJ	<.5676 UJ	<.6530 UJ	<.6125 UJ
Sr-90	.07 R	0.18 UJ	0.29 R	0.03 R	-0.10 UJ	0.10 UJ	-2.00 UJ	0.17 UJ
Tc-99	.1 UJ	0.05 UJ	0.10 UJ	0.20 UJ	0.50 R	0.60 J	0.20 R	0.40 J

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

[a]Duplicate sample taken.

Table D-1. Tree Leaf Sample Results Collected from 100 Areas in 1991.
(sheet 2 of 2)

Constituent	Sample Identification Numbers and Locations							
	Below H	Below H	Below F	Below F	Below BC	Below BC	Above H	Above H
	B00VY9	B00VZ0	B00VZ7	B00VZ8	B00VV7	B00VV8	B00VY1	B00VY2
Aluminum	291.00 J	1500.00 J	226.00 J	301.00 J	317.00 J	460.00 J	1030.00 J	561.00 J
Antimony	3.20 UJ	3.20 UJ	3.40 J	3.20 J	3.20 UJ	3.20 UJ	3.20 UJ	3.20 UJ
Arsenic	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.60 J	1.00 UJ	1.00 UJ	1.00 UJ
Barium	199.00 J	222.00 J	124.00 J	235.00 J	216.00 J	252.00 J	306.00 J	189.00 J
Beryllium	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ	0.20 UJ
Cadmium	0.40 UJ	0.40 UJ	1.50 J	0.44 J	0.40 UJ	0.48 J	0.98 J	0.78 J
Calcium	144000.00	142000.00 J	123000.00 J	140000.00 J	118000.00 J	132000.00 J	134000.00 J	165000.00 J
Chromium	1.80 J	2.30 J	1.90 J	3.20 J	1.30 J	2.20 J	3.30 J	5.70 J
Cobalt	0.85 J	0.64 J	4.40 J	0.96 J	0.60 UJ	1.20 J	1.10 J	0.85 J
Copper	34.30 J	39.30 J	36.20 J	39.40 J	27.50 J	20.80 J	92.50 J	66.80 J
Iron	908.00 J	817.00 J	627.00 J	722.00 J	699.00 J	839.00 J	1170.00 J	1410.00 J
Lead	1.60 J	1.50 J	0.67 J	1.50 J	1.30 J	2.30 J	5.20 J	5.60 J
Magnesium	19300.00 J	20100.00 J	46000.00 J	19200.00 J	17100.00 J	13000.00 J	21700.00 J	37500.00 J
Manganese	258.00 J	125.00 J	288.00 J	187.00 J	86.70 J	139.00 J	265.00 J	377.00 J
Nickel	1.80 J	2.20 J	1.50 J	3.50 J	2.90 J	3.60 J	6.50 J	7.40 J
Potassium	114000.00 J	96000.00 J	98500.00 J	112000.00 J	112000.00 J	72100.00 J	200000.00 J	159000.00 J
Selenium	4.00 UJ	4.00 UJ	4.00 UJ	4.00 UJ	5.50 J	4.00 UJ	4.00 R	4.00 R
Silver	0.71 J	0.76 J	2.80 J	0.50 J	0.40 UJ	0.40 J	0.52 J	1.90 J
Sodium	240.00 J	308.00 J	941.00 J	195.00 J	369.00 J	628.00 J	414.00 J	660.00 J
Thallium	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ	0.40 UJ	2.00 UJ	0.40 UJ
Vanadium	1.00 J	0.90 J	0.94 J	1.10 J	1.10 J	1.60 J	1.30 J	1.70 J
Zinc	148.00 J	143.00 J	156.00 J	233.00 J	106.00 J	139.00 J	468.00 J	398.00 J
Cyanide	NR	NR	NR	NR	NR	NR	NR	NR
Cs-137	<1.049 UJ	<1.048 UJ	<.9581 UJ	<1.243	<.4480 UJ	<.3427 UJ	<2.758 UJ	<1.286 UJ
Sr-90	2.40 J	0.01 R	-0.60 UJ	0.33 J	0.06 UJ	0.70 J	0.43 J	0.30 UJ
Tc-99	0.70 J	1.40 J	0.20 UJ	0.01 UJ	0.10 UJ	2.00 J	0.70 R	0.10 UJ

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/g.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

[a]Duplicate sample taken.

Table D-2. Tree Leaf Results Collected in July 1992 at 100 Area Reactor Sites. (sheet 1 of 2)

Constituent	Reactor site					
	Below F	Below F	Below H	Below H	Below H	Above H
	B06N49	B06N50	B06N51[a] (B06N52)	B06N52 Duplicate	B06N53	B06N54
Aluminum	58.40 B	45.60 B	59.60 B	38.80 B	43.40 B	40.80 B
Antimony	13.80 U	8.10 U	9.20 U	9.30 U	8.70 U	8.40 U
Arsenic	3.30 J	1.60 J	1.70 J	2.10 J	1.90 J	2.10 J
Barium	17.50 B	36.40 B	38.40 B	39.00 B	32.30 B	26.40 B
Beryllium	0.59 U	0.34 U	0.39 U	0.40 U	0.37 U	0.35 U
Cadmium	1.30 U	0.73 U	0.83 U	0.85 U	0.79 U	0.76 U
Calcium	19700.00	24700.00	24400.00	25100.00	21500.00	26200.00
Chromium	4.10 U	2.40 U	2.70 U	2.80 U	2.60 U	2.50 U
Cobalt	2.90 U	1.70 U	1.90 U	2.00 U	1.80 U	1.80 U
Copper	25.20	9.20 B	6.70 B	8.10 B	4.40 B	6.50 B
Iron	206.00 J	120.00 J	136.00 J	118.00 J	108.00 J	140.00 J
Lead	3.00	2.70	1.70	2.10	1.50 U	1.60
Magnesium	4590.00	3710.00	3190.00	3150.00	3260.00	5500.00
Manganese	34.30	17.50	30.60	28.00	19.30	69.90
Mercury	0.71 J	0.32 J	1.40 J	0.59 J	0.58 J	0.57 J
Nickel	5.00 U	2.90 U	3.30 U	3.40 U	3.20 U	3.00 U
Potassium	25900.00	16000.00	16600.00	16300.00	18000.00	10700.00
Selenium	4.70	2.70 J	2.80	2.60 B	2.40 B	1.90 J
Silver	4.00 U	2.30 U	2.70 U	2.70 U	2.50 U	2.40 U
Sodium	320.00 B	230.00 B	171.00 U	199.00 U	168.00 U	198.00 U
Thallium	3.50 UJ	2.20 U	2.40 U	2.40 U	2.30 U	2.10 U
Vanadium	2.80 U	1.60 U	1.80 U	1.90 U	1.70 U	1.70 U
Zinc	49.60 J	36.70 J	29.80 J	23.70 J	17.30 J	33.40 J
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U
Sr-90	-0.007 R	0.340	0.330	0.001	2.600	-0.390 R
Tritium	-0.046	0.071	-0.005	-0.038	-0.038	0.320

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected, associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected, value reported is sample quantitation limit.
UJ = Not detected, may not accurately reflect sample quantitation limit.

[a]Duplicate sample taken.

Table D-2. Tree Leaf Results Collected in July 1992 at 100 Area Reactor Sites. (sheet 2 of 2)

Constituent	Reactor site							
	Below D	Below D	Above D	Below K	Above K	Below BC	Above BC	Control
	B06N55	B06N56	B06N57	B06N58	B06N59	B06N60	B06N61	B06N62
Aluminum	26.10 B	47.20 B	41.70 B	105.00	35.50 B	67.00 B	49.90 B	161.00
Antimony	8.30 U	9.50 U	7.10 U	8.50 U	9.00 U	8.90 U	8.40 U	9.30 U
Arsenic	1.30 UJ	1.60 J	1.40 J	2.10 J	2.40 J	1.40 UJ	1.70 J	1.60 J
Barium	24.30 B	26.90 B	36.80 B	14.10 B	64.30 B	35.30 B	40.70 B	31.50 B
Beryllium	0.35 U	0.40 U	0.30 U	0.36 U	0.38 U	0.38 U	0.36 U	0.39 U
Cadmium	0.76 U	0.86 U	0.64 U	0.77 U	0.82 U	0.81 U	0.77 U	0.84 U
Calcium	17500.00	18600.00	18800.00	21700.00	35700.00	25100.00	28900.00	22500.00
Chromium	2.50 U	3.90	3.20 J	4.10	3.40	2.70 U	2.50 U	4.20
Cobalt	1.80 U	2.00 U	1.50 U	1.80 U	1.90 U	1.90 U	1.80 U	2.00 U
Copper	6.10 B	7.80 B	5.50 B	8.10 B	5.80 B	4.50 B	6.60 B	6.80 B
Iron	89.40 J	102.00 J	109.00 J	203.00 J	148.00 J	138.00 J	147.00 J	321.00 J
Lead	2.00	2.80	1.70	1.60	1.50 U	1.40 U	1.80	3.10
Magnesium	4190.00	1940.00 B	4530.00	3180.00	3190.00	1830.00 B	4690.00	3030.00
Manganese	9.40	22.30	25.00	32.70	24.00	23.60	36.50	20.40
Mercury	0.31 J	0.67 J	2.00 J	1.40 J	1.40 J	2.70 J	0.38 J	0.98 J
Nickel	3.00 U	5.10 B	2.60 U	3.10 U	3.30 U	3.20 U	3.10 U	3.40 U
Potassium	14600.00	17500.00	13300.00	15900.00	15800.00	18400.00	14400.00	17800.00
Selenium	2.30 B	2.20 B	2.00 B	1.90 UJ	1.90 UJ	2.50 B	1.90 UJ	2.30 B
Silver	2.40 U	2.80 U	2.10 U	2.50 U	2.60 U	2.60 U	2.50 U	2.70 U
Sodium	185.00 U	175.00 U	191.00 U	156.00 U	167.00 U	220.00 U	155.00 U	182.00 U
Thallium	2.20 U	2.40 U	1.90 U	2.20 U	2.30 U	2.30 U	2.20 U	2.40 U
Vanadium	1.70 U	1.90 U	1.40 U	1.70 U	1.80 U	1.80 U	1.70 U	1.90 U
Zinc	26.00 J	35.00 J	28.50 J	18.80 J	19.50 J	22.20 J	20.80 J	19.40 J
Cyanide	NR	NR	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U	U	U
Sr-90	0.230	0.260 R	0.270	35.00	-0.330	6.800 R	0.180	0.150
Tritium	-0.063	0.640	-0.018	0.730	0.005	3.600	2.100	0.014

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected, associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected, value reported is sample quantitation limit.
UJ = Not detected, may not accurately reflect sample quantitation limit.

[a]Duplicate sample taken.

Table D-3. Tree Leaf Results Collected in October 1992. (Part I)

Constituent	Sample Media, Locations, and Sample Numbers					
	Limbs Below BC B07925	Leaves Below BC B07926	Leaves Below BC B07927	Limbs Below BC B07928	Limbs Above K B07930	Leaves Above K B07931
Cs-137	U	U	U	U	U	U
Sr-90	9.90 J	23.00 J	13.00 J	7.10 J	-0.37 UJ	0.16 UJ
Tritium	3.0 J	1.2 J	1.0 J	3.8 J	0.34 J	0.26 J

Table D-3. Tree Leaf Results Collected in October 1992. (Part II)

Constituent	Sample Media, Locations, and Sample Numbers					
	Limbs Above K B07932	Leaves Above K B07933	Limbs Below K B07929	Leaves Below K B07934	Limbs Below K B07935	Leaves Below K B07936
Cs-137	U	U	U	U	U	U
Sr-90	0.068 UJ	0.35 UJ	43.00 J	88.00 J	-0.16 UJ	0.55 UJ
Tritium	0.34 J	0.12 J	0.39 J	0.26 J	1.8 J	0.75 J

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

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APPENDIX E

ANALYTICAL RESULTS FOR COYOTES AND RAPTORS

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Table E-1. Coyote Results from 1992. (sheet 1 of 2)

Analyte	Sample Locations and Identification Numbers					
	D B06ND0	D B06ND1	D B06ND7	F B06ND8	F B06NF0	H B07913
Aluminum	2000.00 J	1020.00 J	760.00 J	905.00 J	1960.00 J	1550.00
Antimony	3.60 UJ	3.30 UJ	3.60 UJ	3.50 UJ	3.50 UJ	3.60 UJ
Arsenic	2.90 R	2.90 R	3.00 R	2.90 R	3.10 R	3.40 UJ
Barium	53.10	27.40 B	53.50	22.00 B	41.30 B	33.90 B
Beryllium	0.09 U	0.09 B	0.09 U	0.08 U	0.08 U	0.27 U
Cadmium	0.73 U	0.20 U	0.58 U	0.36 U	0.21 U	4.10
Calcium	87300.00 J	12000.00 J	162000.00 J	35800.00 J	111000.00 J	156000.00
Chromium	6.50	1.30 U	4.00	2.80	5.00	7.10
Cobalt	1.80 B	1.50 B	0.57 U	0.81 B	1.70 B	1.50 B
Copper	15.20	14.30	12.00	12.50	17.50	13.90
Iron	5450.00 J	4630.00 J	1660.00 J	2420.00 J	4800.00 J	2930.00
Lead	11.50	1.60	13.90	5.60	5.70	7.50 R
Magnesium	4660.00	4100.00	4360.00 J	1500.00	5860.00	4950.00
Manganese	194.00 J	88.10 J	152.00	60.30 J	82.60 J	107.00
Mercury	NR	NR	NR	NR	NR	NR
Nickel	3.30 B	4.00 B	1.40 B	2.50 B	3.30 B	2.70 B
Potassium	2890.00 J	8350.00 J	2600.00 J	1790.00 J	967.00 J	2510.00
Selenium	3.70 R	3.80 R	4.00 R	3.80 R	4.00 R	4.20 UJ
Silver	0.53 U	0.49 U	0.53 U	0.52 U	0.52 U	0.54 U
Sodium	697.00 J	2070.00 J	4370.00 J	743.00 J	798.00 J	3030.00 J
Thallium	0.80 B	0.26 U	0.27 U	0.26 U	0.27 U	0.82 UJ
Vanadium	10.20 B	5.40 B	3.60 B	4.20 B	8.30 B	6.50 B
Zinc	240.00	44.50	294.00	282.00	295.00	367.00
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	U	U	0.44	U	U	U
Sr-90	-0.39	0.50	0.073	0.15	4.50	0.29

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table E-1. Coyote Results from 1992. (sheet 2 of 2)

Analyte	Sample Locations and Identification Numbers				
	F B07917	Control B06ND2	Control B06ND4	Control B06ND5	Control B06ND6
Aluminum	2340.00	3970.00 J	2480.00 J	3040.00 J	2530.00 J
Antimony	3.60 UJ	3.50 UJ	3.40 UJ	3.50 UJ	3.30 UJ
Arsenic	3.40 UJ	2.90 R	3.00 R	3.00 R	2.80 R
Barium	86.50	69.80	55.50	38.50 B	82.70
Beryllium	0.52 U	0.08 U	0.08 U	0.08 U	0.08 U
Cadmium	1.10	0.20 U	0.20 U	0.21 U	0.20 J
Calcium	95000.00	37800.00 J	73300.00 J	46000.00 J	72300.00
Chromium	5.90	5.40	4.50	5.30	3.50
Cobalt	1.90 B	4.70 B	2.70 B	3.00 B	1.60 B
Copper	22.00	11.30	18.10	13.10	21.20
Iron	4880.00	11300.00 J	5090.00 J	6110.00 J	4300.00 J
Lead	9.00 R	2.30	2.90	3.70	3.80
Magnesium	5590.00	4020.00	4430.00	3330.00	4260.00
Manganese	261.00	206.00 J	116.00 J	109.00 J	123.00 J
Mercury	NR	NR	NR	NR	NR
Nickel	3.40 B	4.90 B	3.60 B	4.90 B	3.20 B
Potassium	2210.00	1670.00 J	2570.00 J	811.00 J	6900.00 J
Selenium	4.10 UJ	3.80 R	3.90 R	3.90 R	3.70 R
Silver	0.53 U	0.51 U	0.51 U	0.51 U	0.50 U
Sodium	2320.00 J	462.00 J	6500.00 J	674.00 J	1640.00 J
Thallium	0.80 UJ	0.26 U	0.27 U	0.27 U	0.25 U
Vanadium	9.70 B	22.40	10.30	11.40	7.60 B
Zinc	295.00	117.00	204.00	70.60	174.00
Cyanide	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U
Sr-90	0.44 R	0.21	0.11	0.00	0.006

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table E-2. Raptor Results from 1992.

Constituent	Sample Locations and Identification Numbers						
	F B06ND8	H B07914	F B07915	F B07916	Control B07919	Control B06ND3	Control B06ND5
Aluminum	905.00 J	835.00	834.00	1210.00	1170.00	1550.00 J	3040.00 J
Antimony	3.50 UJ	3.80 UJ	3.70 UJ	3.60 UJ	3.60 UJ	3.50 UJ	3.50 UJ
Arsenic	2.90 R	3.60 U	3.40 UJ	3.50 UJ	3.50 UJ	2.90 R	3.00 R
Barium	22.00 B	58.20	74.10	61.10	63.40	45.10	38.50 B
Beryllium	0.08 U	0.14 U	0.09 U	0.27 U	0.26 U	0.08 U	0.08 U
Cadmium	0.36 U	0.51 U	0.22 U	0.22 U	0.22 U	0.21 U	0.21 U
Calcium	35800.00 J	198000.00	114000.00	116000.00	143000.00	93200.00 J	46000.00 J
Chromium	2.80	5.00	3.30	3.70	4.10	3.40	5.30
Cobalt	0.81 B	0.86 B	0.84 B	0.69 B	0.97 B	1.30 B	3.00 B
Copper	12.50	5.90	20.20	14.40	18.50	20.50	13.10
Iron	2420.00 J	1510.00	1960.00	2700.00	2530.00	3510.00 J	6110.00 J
Lead	5.60	10.30 R	3.10 R	4.90 R	1.80 R	2.40	3.70
Magnesium	1500.00	3680.00	3860.00	3290.00	4040.00	2400.00	3330.00
Manganese	60.30 J	439.00	57.00	74.50	69.90	93.00 J	109.00 J
Mercury	NR	NR	NR	NR	NR	NR	NR
Nickel	2.50 B	1.20 U	1.20 B	1.90 B	1.40 B	3.20 B	4.90 B
Potassium	1790.00 J	1680.00	1120.00	1120.00	1930.00	1540.00 J	811.00 J
Selenium	3.80 R	4.40 UJ	4.20 UJ	4.20 UJ	4.20 UJ	3.70 R	3.90 R
Silver	0.52 U	0.56 U	0.55 U	0.54 U	0.54 U	0.52 U	0.51 U
Sodium	743.00 J	2110.00 J	5060.00 J	3980.00 J	2510.00 J	1390.00 J	674.00 J
Thallium	0.26 U	0.86 UJ	0.82 U	0.82 U	0.82 U	0.26 U	0.27 U
Vanadium	4.20 B	3.90 B	3.70 B	5.40 B	4.60 B	7.80 B	11.40
Zinc	282.00	585.00	268.00	266.00	307.00	267.00	70.60
Cyanide	NR	NR	NR	NR	NR	NR	NR
Cs-137	U	U	U	U	U	U	U
Sr-90	0.15	0.10	4.70 J	0.035	0.37 J	0.74	0

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

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APPENDIX F

ANALYTICAL RESULTS FOR ANT MOUNDS

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Table F-1. Ant Mound Soil Results from 1992 at F Reactor.

Constituent	Sample Identification Numbers and Locations				
	126-F-1	126-F-1	126-F-14	118-F-2	Control
	B06N95	B06N98	B06NB0	B06NB2	B07918
Aluminum	8140.00	6000.00	6020.00	4550.00	4560.00
Antimony	3.10 R	3.30 R	3.40 UJ	3.30 UJ	3.10 UJ
Arsenic	0.57 B	0.61 B	1.70 U	2.10	2.30
Barium	316.00	230.00	81.70	55.90	68.30
Beryllium	0.61 U	0.67 U	0.49 B	0.38 B	0.13 U
Cadmium	0.18 U	0.20 U	0.20 U	0.20 U	0.18 U
Calcium	9320.00	7080.00	3660.00	3410.00	8180.00
Chromium	6.40	5.30	8.40	7.00	5.50
Cobalt	7.00 B	8.80 B	7.40 B	7.30 B	10.10
Copper	13.50	12.30	13.60	10.40	12.60
Iron	13200.00	15500.00	15500.00	15500.00	19800.00
Lead	5.80 J	3.40 J	3.00	3.80	5.50 R
Magnesium	4170.00	4410.00	3840.00	3690.00	4020.00
Manganese	211.00	257.00	240.00	227.00	269.00
Mercury	0.05 U	0.05 U	0.04 U	0.04 U	0.05 U
Nickel	8.20	7.90	8.40	6.70 B	6.50 B
Potassium	1270.00	1280.00	1080.00	1230.00	990.00
Selenium	0.72 UJ	0.75 UJ	0.71 UJ	0.69 U	0.68 UJ
Silver	0.45 U	0.64 U	0.51 U	0.49 U	0.81 B
Sodium	482.00 J	593.00 J	165.00 J	132.00 J	198.00 J
Thallium	0.72 U	0.75 U	0.26 U	0.25 U	0.66 UJ
Vanadium	35.40	41.60	40.40	36.70	52.20
Zinc	32.20	35.70	39.60	32.60	43.30
Cyanide	NR	NR	NR	NR	NR
Cs-137	U	U	0.11	U	0.071
Sr-90	-0.3	-0.06	0.34	0.23	0.36

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table F-2. Ant Mound Results From H Reactor Collected in 1992.

Constituent	Sample Identification Numbers and Locations					
	118-H-3	118-H-3	118-H-7	118-H-7	118-H-2	Control
	B06NB4	B06NB5	B06NB8	B06NB9	B06NC1	B07918
Aluminum	3780.00	5100.00	3430.00	3600.00	5270.00	4560.00
Antimony	3.20 UJ	3.00 UJ	3.10 UJ	3.20 UJ	3.30 UJ	3.10 UJ
Arsenic	2.30	4.00	4.80	1.30 U	2.60	2.30
Barium	48.90	62.90	64.90	44.10	65.80	68.30
Beryllium	0.35 B	0.42 B	0.32 B	0.34 B	0.35 B	0.13 U
Cadmium	0.19 U	0.18 U	0.18 U	0.19 U	0.19 U	0.18 U
Calcium	4030.00	3680.00	3610.00	4360.00	3370.00	8180.00
Chromium	5.70	6.50	5.40	4.70	7.80	5.50
Cobalt	5.80 B	6.40 B	5.10 B	6.00 B	6.80 B	10.10
Copper	10.80	12.00	13.00	12.70	10.50	12.60
Iron	12600.00	14100.00	10700.00	12800.00	13500.00	19800.00
Lead	3.50	15.50	24.30	6.20 J	12.20	5.50 R
Magnesium	3070.00	3260.00	2650.00	2920.00	3430.00	4020.00
Manganese	174.00	223.00	157.00	183.00	240.00	269.00
Mercury	0.05 U	0.04 U	0.05 U	0.04 U	0.05 U	0.05 U
Nickel	6.70 B	6.90 B	5.80 B	5.50 B	7.10 B	6.50 B
Potassium	838.00 B	1370.00	785.00 B	855.00 B	1380.00	990.00
Selenium	0.63 U	0.62 U	0.68 UJ	0.72 U	0.64 U	0.68 UJ
Silver	0.48 U	0.44 U	0.47 U	0.66 U	0.52 U	0.81 B
Sodium	112.00 J	136.00 J	135.00 J	127.00 J	115.00 J	198.00 J
Thallium	0.23 U	0.23 U	0.25 U	0.26 U	0.23 U	0.66 UJ
Vanadium	27.50	30.60	23.70	29.50	27.40	52.20
Zinc	27.30	33.60	30.80	32.00	33.60	43.30
Cyanide	NR	NR	NR	NR	NR	NR
CS-137	0.34	0.19	0.26	U	0.25	0.071
SR-90	0.15	0.17	0.045	0.052	0.10	0.36

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected, associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected, value reported is sample quantitation limit.
UJ = Not detected, may not accurately reflect sample quantitation limit.

Table F-3. Ant Mound Results From D Reactor Collected in 1992.

Constituent	Sample Identification Numbers and Locations				
	116-DR-9	116-DR-9	116-D-4	116-D-2	Control
	B06NC2	B06NC4	B06NC6	B06NC8	B07918
Aluminum	4780.00	4220.00	5100.00	4470.00	4560.00
Antimony	3.00 UJ	3.40 UJ	3.20 UJ	3.30 U	3.10 UJ
Arsenic	1.10 U	1.30 U	1.30 U	1.70 U	2.30
Barium	93.40	87.70	82.50	57.40	68.30
Beryllium	0.45 B	0.22 B	0.49 B	0.30 B	0.13 U
Cadmium	0.18 U	0.20 U	0.19 U	0.20 U	0.18 U
Calcium	5880.00	6340.00	5310.00	7930.00	8180.00
Chromium	6.10	5.20	6.60	4.90	5.50
Cobalt	9.10	10.80	9.90	9.40 B	10.10
Copper	14.10	14.20	12.90	13.30	12.60
Iron	18500.00	21100.00	18900.00	19400.00	19800.00
Lead	8.00	5.60	5.20	4.40	5.50 R
Magnesium	4280.00	4310.00	4060.00	4110.00	4020.00
Manganese	260.00	268.00	262.00	266.00	269.00
Mercury	0.04 U	0.05 U	0.05 U	0.05 U	0.05 U
Nickel	9.20	6.90 B	7.50 B	6.90 B	6.50 B
Potassium	1300.00	955.00 B	983.00	1450.00	990.00
Selenium	0.63 U	0.68 U	0.70 U	0.70 U	0.68 UJ
Silver	0.45 U	1.10 U	0.62 U	0.83 U	0.81 B
Sodium	174.00 J	192.00 J	218.00 J	228.00 J	198.00 J
Thallium	0.23 U	0.24 U	0.25 U	0.25 U	0.66 UJ
Vanadium	40.40	48.50	47.20	43.60	52.20
Zinc	47.90	45.70	39.10	40.80	43.30
Cyanide	NR	NR	NR	NR	NR
CS-137	0.36	0.34	0.43	0.31	0.071
SR-90	0.42	0.11	0.096	0.24	0.36

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected, associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected, value reported is sample quantitation limit.
UJ = Not detected, may not accurately reflect sample quantitation limit.

Table F-4. Ant Mound Results from N Reactor in 1992.

Constituent	Sample Identification Numbers and Locations				
	116-N-1	116-N-1	116-N-1	116-N-1	Control
	B07908	B07909* (B07910)	B07910 Duplicate	B07911	B07918
Aluminum	6530.00	7770.00	7580.00	7560.00	4560.00
Antimony	3.40 UJ	3.30 UJ	3.30 UJ	3.20 UJ	3.10 UJ
Arsenic	3.20	1.60 B	2.10	2.30	2.30
Barium	68.70	79.70	77.10	80.60	68.30
Beryllium	0.34 U	0.13 U	0.10 U	0.10 U	0.13 U
Cadmium	0.20 U	0.20 U	0.20 U	0.19 U	0.18 U
Calcium	5730.00	4240.00	3630.00	4060.00	8180.00
Chromium	8.20	8.80	10.00	8.90	5.50
Cobalt	9.50 B	10.70	9.60 B	9.00 B	10.10
Copper	14.90	14.70	13.70	15.20	12.60
Iron	19100.00	22600.00	18600.00	18600.00	19800.00
Lead	4.00 R	3.50 R	4.80 R	4.40 R	5.50 R
Magnesium	4240.00	4240.00	3930.00	3990.00	4020.00
Manganese	308.00	391.00	360.00	339.00	269.00
Mercury	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nickel	9.70	9.50	9.50	9.30	6.50 B
Potassium	1700.00	2260.00	2230.00	2440.00	990.00
Selenium	0.70 UJ	0.77 UJ	0.71 UJ	0.77 UJ	0.68 UJ
Silver	0.54 B	1.00 B	0.99 B	0.65 B	0.81 B
Sodium	219.00 J	206.00 J	198.00 J	203.00 J	198.00 J
Thallium	0.68 U	0.75 U	0.69 UJ	0.75 U	0.66 UJ
Vanadium	40.60	54.00	41.20	41.60	52.20
Zinc	45.80	53.50	45.40	49.90	43.30
Cyanide					
Cs-137	0.19	0.52	0.52	0.14	0.07
Sr-90	0.26	-0.62	-0.06	0.50	0.36

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

*Duplicate sample taken.

Table F-5. Ant Mound Soil Results from BC Reactor in 1992.

Constituent	Sample Identification Numbers and Locations					
	118-B-1	118-C-4	118-C-4	118-C-1	118-C-1	Control
	B078Z0	B078Z4	B078Z5	B078Z6	B078Z7	B07918
Aluminum	8430.00	6210.00	5550.00	5790.00	5280.00	4560.00
Antimony	3.10 R	3.40 R	3.10 R	3.00 R	3.20 R	3.10 UJ
Arsenic	2.00	0.99 B	0.57 U	0.74 B	0.79	2.30
Barium	316.00	323.00	57.20	73.10	57.30	68.30
Beryllium	0.54 U	0.66 U	0.64 U	0.52 U	0.40 U	0.13 U
Cadmium	0.18 U	0.20 U	0.18 U	0.18 U	0.19 U	0.18 U
Calcium	9630.00	6460.00	4220.00	4080.00	5020.00	8180.00
Chromium	7.20	4.80	6.30	6.90	13.20	5.50
Cobalt	8.50 B	9.80 B	10.20	9.00	11.70	10.10
Copper	19.60	16.50	17.80	15.70	17.20	12.60
Iron	16100.00	18100.00	19400.00	17000.00	20800.00	19800.00
Lead	4.50 J	8.10 J	9.90 J	12.10 J	8.30 J	5.50 R
Magnesium	4370.00	4060.00	4130.00	3740.00	4210.00	4020.00
Manganese	263.00	298.00	280.00	289.00	300.00	269.00
Mercury	0.04 U	0.05 U	0.05 U	0.04 U	0.04 U	0.05 U
Nickel	8.40	7.40 B	9.30	7.60	13.30	6.50 B
Potassium	1670.00	1540.00	1390.00	1710.00	1010.00	990.00
Selenium	0.69 UJ	0.73 UJ	0.75	0.73 UJ	0.76 UJ	0.68 UJ
Silver	0.46 U	0.50 U	1.30 U	0.87 U	1.00 U	0.81 B
Sodium	467.00 J	256.00 J	193.00 J	163.00 J	212.00 J	198.00 J
Thallium	0.69 U	0.73 U	0.75 U	0.73 U	0.76 U	0.66 UJ
Vanadium	40.80	37.40	43.10	38.30	51.80	52.20
Zinc	46.00	41.50	46.50	49.00	53.90	43.30
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	0.15	0.21	0.45	0.24	0.37	
Sr-90	0.07	0.088	-0.06	-0.28	-0.620	
Tc-99						

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

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APPENDIX G

ANALYTICAL RESULTS FOR SMALL MAMMAL BURROWS

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Table G-1. Burrow Mound Soil Results from F Reactor in 1992.

Constituent	Sample Identification Numbers and Locations					
	126-F-1	126-F-1	Surf. Cont.	116-F-1	118-F-2	Control
	B06N96	B06N97	B06N99	B06NB1	B06NB3	B07920
Aluminum	6220.00	6380.00	4960.00	5930.00	5590.00	7630.00
Antimony	3.40 R	3.10 R	3.40 R	3.30 UJ	3.30 UJ	3.20 UJ
Arsenic	0.57 U	0.80 B	1.00 B	1.90	1.10 U	3.00
Barium	86.00	218.00	78.70	144.00	58.00	105.00
Beryllium	0.39 U	0.54 U	0.39 U	0.49 B	0.40 B	0.13 U
Cadmium	0.20 U	0.18 U	0.20 U	0.20 U	0.19 U	0.19 U
Calcium	3710.00	6070.00	3970.00	5230.00	3300.00	11700.00
Chromium	6.50	7.40	6.60	8.40	8.10	10.90
Cobalt	8.90 B	8.50 B	8.20 B	7.80 B	9.10 B	10.40
Copper	10.40	12.40	10.20	11.40	9.40	11.60
Iron	17100.00	16200.00	15200.00	16100.00	18900.00	20900.00
Lead	3.50 J	4.30 J	8.50 J	5.10	5.50	13.50 R
Magnesium	3800.00	4220.00	3900.00	3980.00	3800.00	4810.00
Manganese	284.00	287.00	241.00	235.00	272.00	388.00
Mercury	0.05 U	0.05 U	0.05 U	0.05 U	0.04 U	0.05 U
Nickel	8.60	8.10	9.10	7.70 B	7.90	9.70
Potassium	1350.00	1560.00	1310.00	1030.00	1600.00	1870.00
Selenium	0.75 U	0.68 UJ	0.72 UJ	0.67 U	0.69 U	0.77 UJ
Silver	0.78 U	0.61 U	0.60 U	0.87 U	1.10 U	0.87 B
Sodium	184.00 J	279.00 J	182.00 J	264.00 J	142.00 J	208.00 J
Thallium	0.75 U	0.68 U	0.72 U	0.24 U	0.25 U	0.75 U
Vanadium	42.80	41.40	39.50	44.00	52.10	52.10
Zinc	36.40	36.00	36.30	34.20	38.60	115.00
Cyanide	NR	NR	NR	NR	NR	NR
Cs-137	U	0.08	0.17	0.34	U	U
Sr-90	-0.027	0.200	0.063	0.220	0.00	0.091

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table G-2. Burrow Results from H Reactor Collected in 1992.

Constituent	Sample Identification Numbers and Locations			
	118-H-3	118-H-3	118-H-7	Control
	B06NB6	B06NB7	B06NC0	B07920
Aluminum	7520.00	9790.00	4990.00	7630.00
Antimony	3.00 UJ	3.40 UJ	3.30 UJ	3.20 UJ
Arsenic	3.10	4.50	3.30	3.00
Barium	102.00	105.00	46.90	105.00
Beryllium	0.59 B	0.59 B	0.37 B	0.13 U
Cadmium	0.18 U	0.20 U	0.19 U	0.19 U
Calcium	4690.00	3630.00	5340.00	11700.00
Chromium	8.90	12.20	7.70	10.90
Cobalt	6.80 B	9.90 B	6.60 B	10.40
Copper	14.20	12.80	11.10	11.60
Iron	15800.00	20600.00	14200.00	20900.00
Lead	17.00	14.90	5.90	13.50 R
Magnesium	4200.00	4710.00	3790.00	4810.00
Manganese	314.00	370.00	223.00	388.00
Mercury	0.05 U	0.05 U	0.04 U	0.05 U
Nickel	8.90	12.00	8.30	9.70
Potassium	2340.00	2480.00	771.00 B	1870.00
Selenium	0.70 UJ	0.68 UJ	0.70 U	0.77 UJ
Silver	0.58 U	1.10 U	0.48 U	0.87 B
Sodium	188.00 J	157.00 J	119.00 J	208.00 J
Thallium	0.25 UJ	0.25 U	0.25 U	0.75 U
Vanadium	32.20	44.00	35.90	52.10
Zinc	49.60	46.00	29.80	115.00
Cyanide	NR	NR	NR	NR
CS-137	0.50	U	U	U
SR-90	-0.39	0.079	0.31	0.091

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table G-3. Burrow Results from D Reactor Collected in 1992.

Constituent	Sample Identification Numbers and Locations				
	116-DR-9	116-D-3	116-D-1	116-D-2	Control
	B06NC3	B06NC5	B06NC7	B06NC9	B07920
Aluminum	5540.00	6960.00	5660.00	5110.00	7630.00
Antimony	3.40 UJ	3.20 UJ	3.00 UJ	3.20 U	3.20 UJ
Arsenic	2.70	3.10 J	2.50	1.60 U	3.00
Barium	100.00	103.00	81.50	56.80	105.00
Beryllium	0.68 B	0.39 B	0.38 B	0.48 B	0.13 U
Cadmium	0.20 U	0.19 U	0.18 U	0.19 U	0.19 U
Calcium	11700.00	9010.00	6650.00	4150.00	11700.00
Chromium	7.70	9.30	8.10	8.00	10.90
Cobalt	8.90 B	9.20 B	10.00	8.60 B	10.40
Copper	14.60	13.20	13.40	10.90	11.60
Iron	17600.00	19200.00	20100.00	17100.00	20900.00
Lead	4.90	4.60	4.70	7.60	13.50 R
Magnesium	4480.00	4580.00	4370.00	3980.00	4810.00
Manganese	278.00	319.00	296.00	235.00	388.00
Mercury	0.04 U	0.04 U	0.04 U	0.05 U	0.05 U
Nickel	8.60	10.50	8.50	9.20	9.70
Potassium	1370.00	1610.00	1230.00	1400.00	1870.00
Selenium	0.68 UJ	0.66 UJ	0.63 U	0.64 U	0.77 UJ
Silver	0.72 U	0.74 U	0.82 U	0.80 U	0.87 B
Sodium	167.00 J	154.00 J	176.00 J	200.00 J	208.00 J
Thallium	0.25 U	0.24 UJ	0.23 U	0.23 U	0.75 U
Vanadium	39.90	45.40	50.80	43.40	52.10
Zinc	40.70	40.50	44.50	36.30	115.00
Cyanide	NR	NR	NR	NR	NR
CS-137	0.17	U	0.16	0.16	U
SR-90	0.055	0.18	0.15	0.077	0.091

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table G-4. Burrow Mound Soil Results from 1992 at K Reactor. (sheet 1 of 2)

Constituent	Sample Identification Numbers and Locations			
	118-K-1	118-K-1	118-K-1	116-K-1
	B07829	B07900	B07901	B07902
Aluminum	6140.00	5280.00	5420.00	3870.00
Antimony	3.30 R	3.40 R	3.20 R	3.20 R
Arsenic	2.40	1.90 B	2.10	0.67 B
Barium	57.30	54.40	58.00	43.70
Beryllium	0.35 U	0.26 U	0.35 U	0.28 U
Cadmium	0.19 U	0.20 U	0.19 U	0.19 U
Calcium	6490.00	6110.00	7360.00	5210.00
Chromium	8.00	6.70	6.30	3.60
Cobalt	7.30 B	6.80 B	7.50 B	11.00
Copper	13.30	11.30	11.20	16.00
Iron	14800.00	13400.00	14600.00	18700.00
Lead	8.90 J	7.40 J	4.80 J	5.50 J
Magnesium	4720.00	4190.00	4490.00	3790.00
Manganese	261.00	244.00	266.00	281.00
Mercury	0.04 U	0.05 U	0.04 U	0.05 U
Nickel	9.90	8.40	7.70	7.10 B
Potassium	1620.00	1670.00	1630.00	770.00 B
Selenium	0.70 U	0.73 U	0.74 UJ	0.71 U
Silver	0.60 U	0.50 U	0.50 U	0.73 U
Sodium	155.00 J	138.00 J	149.00 J	215.00 J
Thallium	0.70 U	0.73 U	0.74 U	0.71 U
Vanadium	31.10	26.90	30.90	40.90
Zinc	410.00	496.00	57.40	217.00
Cyanide	NR	NR	NR	NR
Cs-137	0.52	0.45	0.41	U
Sr-90	-0.20	-0.56	-0.78	0.021
Tc-99				

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

*Duplicate sample taken.

Table G-4. Burrow Mound Soil Results from K Reactor in 1992. (sheet 2 of 2)

Constituent	Sample Identification Numbers and Locations			
	116-K-1	116-K-1	116-K-1	Control
	B07903	B07904* (B07905)	B07905 Duplicate	B07920
Aluminum	6510.00	7050.00	3580.00	7630.00
Antimony	3.30 R	3.30 R	3.10 UJ	3.20 UJ
Arsenic	0.93 B	1.30 B	0.88 J	3.00
Barium	69.00	75.60	41.90	105.00
Beryllium	0.47 U	0.56 U	0.18 B	0.13 U
Cadmium	0.20 U	0.19 U	0.18 U	0.19 U
Calcium	3610.00	3740.00	4770.00	11700.00
Chromium	7.90	7.90	3.80	10.90
Cobalt	9.30 B	9.90	9.30	10.40
Copper	14.70	15.50	16.80	11.60
Iron	16800.00	18200.00	18600.00	20900.00
Lead	6.80 J	6.60 J	5.70	13.50 R
Magnesium	3820.00	3970.00	3710.00	4810.00
Manganese	358.00	336.00	251.00 J	388.00
Mercury	0.05 U	0.05 U	0.05 U	0.05 U
Nickel	10.10	9.90	5.90 B	9.70
Potassium	1980.00	2880.00	638.00 B	1870.00
Selenium	0.74	0.75 UJ	0.69 U	0.77 UJ
Silver	0.77 U	0.74 U	0.82 U	0.87 B
Sodium	161.00 J	170.00 J	207.00 J	208.00 J
Thallium	0.74	0.75 U	0.30 U	0.75 U
Vanadium	37.50	39.00	0.51 R	52.10
Zinc	77.70	47.80	213.00 J	115.00
Cyanide	NR	NR	NR	NR
Cs-137	0.14	0.31		U
Sr-90	-0.039	-0.73		0.091
Tc-99				

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

*Duplicate sample taken.

Table G-5. Burrow Results from N Reactor in 1992.

Constituent	Sample Identification Numbers and Locations				
	116-N-2	116-N-3	116-N-1	116-N-1	Control
	B07937	B07906	B07907	B07912	B07920
Aluminum	7110.00	8060.00	9000.00	9020.00	7630.00
Antimony	3.00 UJ	3.30 UJ	3.20 J	3.30 UJ	3.20 UJ
Arsenic	1.80 B	2.80	2.20	2.30	3.00
Barium	66.40	83.70	85.60	85.00	105.00
Beryllium	0.41 U	0.21 U	0.11 U	0.10 U	0.13 U
Cadmium	0.18 U	0.20 U	0.19 U	0.20 U	0.19 U
Calcium	5200.00	3820.00	3660.00	3780.00	11700.00
Chromium	10.70	11.50	12.10	11.30	10.90
Cobalt	8.50 B	9.50 B	9.00 B	9.20 B	10.40
Copper	14.10	15.70	14.10	13.40	11.60
Iron	16200.00	18300.00	18900.00	18500.00	20900.00
Lead	5.20 R	4.40 R	5.70 R	5.50 R	13.50 R
Magnesium	4220.00	4680.00	4400.00	4300.00	4810.00
Manganese	299.00	336.00	357.00	348.00	388.00
Mercury	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nickel	10.90	11.40	11.50	11.90	9.70
Potassium	1670.00	1780.00	2610.00	2270.00	1870.00
Selenium	3.50 UJ	0.71 UJ	0.77 UJ	0.76 UJ	0.77 UJ
Silver	1.20 B	1.20 B	0.60 B	1.10 B	0.87 B
Sodium	163.00 J	186.00 J	185.00 J	207.00 J	208.00 J
Thallium	0.69 UJ	0.69 UJ	0.75 U	0.74 UJ	0.75 U
Vanadium	38.40	37.10	42.50	41.40	52.10
Zinc	43.20	39.40	136.00	87.20	115.00
Cyanide	NR	NR	RN	NR	NR
Cs-137	U	0.23	0.48 R	0.46	U
Sr-90	0.39	1.40	0.46	0.33	0.09

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

Table G-6. Burrow Mound Soil Results from BC Reactor in 1992.

Constituent	Sample Identification Numbers and Locations				
	118-B-1	118-B-1	118-B-1	116-C-5	Control
	B078Z1	B078Z2	B078Z3	B078Z8	B07920
Aluminum	19300.00	19900.00	6040.00	7810.00	7630.00
Antimony	3.30 R	3.40 R	3.20 R	3.40 R	3.20 UJ
Arsenic	2.80	3.50	1.20 B	1.50 B	3.00
Barium	1870.00	1760.00	64.70	78.10	105.00
Beryllium	1.50	1.80	0.36 U	0.66 U	0.13 U
Cadmium	0.20 U	0.20 U	0.19 U	0.20 U	0.19 U
Calcium	NR	35000.00	3400.00	4580.00	11700.00
Chromium	8.80	9.40	7.20	11.20	10.90
Cobalt	9.40 B	12.50	8.40 B	9.00 B	10.40
Copper	26.30	39.20	10.60	16.10	11.60
Iron	16800.00	20600.00	14800.00	16300.00	20900.00
Lead	5.10 J	8.60 J	4.90 J	4.00 J	13.50 R
Magnesium	6870.00	8560.00	3680.00	4440.00	4810.00
Manganese	290.00	333.00	289.00	279.00	388.00
Mercury	0.09 B	0.05 U	0.04 U	0.05 U	0.05 U
Nickel	14.20	17.60	8.30	12.50	9.70
Potassium	2140.00	1650.00	1400.00	1470.00	1870.00
Selenium	3.60 U	3.80 U	0.74 UJ	0.76 UJ	0.77 UJ
Silver	0.78 U	0.50 U	0.48 U	0.71 U	0.87 B
Sodium	1840.00 J	2000.00 J	145.00 J	206.00 J	208.00 J
Thallium	0.72 U	0.75 U	0.74 U	0.76 U	0.75 U
Vanadium	54.10	63.80	33.80	34.60	52.10
Zinc	27.40	34.20	33.80	38.90	115.00
Cyanide	NR	NR	NR	NR	NR
Cs-137	0.22	0.20	U	0.15	U
Sr-90	-0.12	-0.36	0.00	0.20	0.09
Tc-99					

NOTE: All metals are reported in mg/kg. Radionuclides are reported in pCi/gm.

B = Analyte found in associated blank as well as sample.
J = Not detected; associated value is estimated.
NR = Nonreportable.
R = Data are unusable.
U = Not detected; value reported is sample quantitation limit.
UJ = Not detected; may not accurately reflect sample quantitation limit.

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APPENDIX H

RADIONUCLIDE VALUES IN SOIL AND VEGETATION FROM 100 AREAS COLLECTED AS PART OF WESTINGHOUSE HANFORD COMPANY'S ENVIRONMENTAL MONITORING PROGRAM

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Table H-1. Average Radionuclide Concentrations (pCi/g) Detected in Soil Samples near the 1301-N Liquid Waste Disposal Facility from 1980 through 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1980	1.3 E+01	3.5 E-01	4.1 E+00	NR	2.5 E-02
1981	4.0 E+00	7.0 E-01	6.1 E+00	NR	4.4 E-02
1982	6.3 E+00	2.7 E-01	2.7 E+00	NR	1.8 E-02
1983	5.4 E+00	1.3 E+00	3.8 E+00	NR	4.3 E-02
1984	2.8 E+00	2.1 E-01	1.1 E+00	NR	1.7 E-02
1985	1.3 E+01	6.5 E-01	3.9 E+00	NR	3.2 E-02
1986	4.5 E+00	2.2 E-01	2.5 E+00	NR	1.7 E-02
1987	5.1 E+00	3.4 E-01	1.6 E+00	5.4 E-03	2.2 E-02
1988	7.8 E+00	3.5 E-01	2.0 E+00	2.3 E-03	1.7 E-02
1989	2.3 E+00	1.5 E-01	5.0 E-01	6.4 E-03	4.0 E-02
1990	4.7 E+00	3.2 E-01	1.7 E+00	4.6 E-03	3.5 E-02
1991	1.3 E+01	2.7 E-01	1.3 E+00	7.7 E-03	5.3 E-02

NR = Not reported.

Table H-2. Average Radionuclide Concentrations (pCi/g) Detected in 100 N Area Surface Soil Samples from 1980 through 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1980	8.5 E-01	1.8 E-01	5.0 E-01	NR	1.8 E-02
1981	1.3 E+00	2.1 E-01	1.0 E+00	NR	1.1 E-02
1982	1.6 E+00	9.9 E-02	3.4 E-01	NR	5.0 E-03
1983	2.7 E+00	2.9 E-01	4.4 E-01	NR	8.5 E-03
1984	8.8 E-01	2.8 E-01	6.2 E-01	NR	1.4 E-02
1985	1.2 E+00	1.3 E-01	5.2 E-01	NR	1.3 E-02
1986	4.1 E-01	8.3 E-02	5.0 E-01	NR	8.2 E-03
1987	4.1 E-01	1.1 E-01	3.9 E-01	1.1 E-03	6.7 E-03
1988	3.4 E-01	1.6 E-01	3.9 E-01	4.5 E-04	9.5 E-03
1989	1.4 E-01	2.1 E-01	1.3 E-01	1.1 E-03	1.3 E-02
1990	3.0 E-01	1.2 E-01	4.4 E-01	6.7 E-04	1.0 E-02
1991	4.3 E-01	1.1 E-01	4.5 E-01	6.2 E-04	7.8 E-03

NR = Not reported.

Table H-3. Average Radionuclide Concentrations (pCi/g) Detected in 100-B/C Area Surface Soil Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	5.7 E-01	NR	1.2 E+00	NR	NR
1982	8.2 E-01	NR	1.3 E+00	NR	NR
1983	4.2 E-01	NR	1.5 E+00	NR	NR
1984	5.4 E-01	3.2 E-01	1.9 E+00	1.0 E-03	2.4 E-02
1985	2.7 E-01	2.4 E-02	4.5 E-01	2.9 E-04	8.8 E-04
1986	1.8 E-01	1.2 E-01	6.4 E-01	5.5 E-04	8.3 E-03
1987	2.6 E-01	1.1 E-01	9.2 E-01	6.2 E-04	1.4 E-02
1988	2.7 E-01	3.9 E-01	9.5 E-01	6.2 E-04	3.0 E-02
1989	2.6 E-01	3.5 E-01	7.6 E-01	6.2 E-04	5.5 E-02
1990	1.1 E-01	1.7 E-01	7.4 E-01	6.2 E-04	2.9 E-02
1991	6.4 E-01	1.6 E-01	9.0 E-01	9.0 E-04	1.7 E-02

NR = Not Reported.

Table H-4. Average Radionuclide Concentrations (pCi/g) Detected in 100-D/DR Area Surface Soil Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	3.6 E-01	NR	4.0 E-01	NR	NR
1982	4.9 E-01	NR	3.2 E-01	NR	NR
1983	4.2 E-01	NR	1.7 E-01	NR	NR
1984	2.2 E-01	1.4 E-01	1.6 E-01	1.4 E-04	9.8 E-03
1985	2.4 E-01	5.6 E-02	2.7 E-01	2.1 E-04	3.0 E-03
1986	2.6 E-01	7.3 E-02	8.7 E-01	3.2 E-04	5.8 E-03
1987	2.8 E-01	2.0 E-01	1.1 E+00	1.6 E-03	1.8 E-02
1988	1.9 E-01	1.5 E-01	9.4 E-01	6.2 E-04	8.2 E-03
1989	2.2 E-01	8.8 E-02	6.7 E-01	6.2 E-04	1.4 E-02
1990	9.3 E-02	9.8 E-02	9.5 E-01	6.2 E-04	2.9 E-02
1991	1.1 E-01	7.0 E-02	9.8 E-01	3.1 E-04	9.1 E-03

NR = Not Reported.

Table H-5. Average Radionuclide Concentrations (pCi/g) Detected in 100-F Area Surface Soil Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	2.9 E-01	NR	6.0 E-01	NR	NR
1982	1.4 E+00	NR	1.7 E+00	NR	NR
1983	2.7 E-01	NR	8.6 E-01	NR	NR
1984	1.1 E+00	4.4 E-01	7.0 E-01	5.0 E-04	1.0 E-02
1985	3.0 E-01	2.9 E-01	8.3 E-01	6.5 E-04	9.8 E-03
1986	2.3 E-01	2.7 E-01	7.4 E-01	3.8 E-04	1.1 E-02
1987	1.9 E-01	2.4 E-01	5.5 E-01	6.4 E-04	9.3 E-03
1988	1.7 E-01	1.6 E-01	6.2 E-01	1.3 E-03	1.4 E-02
1989	1.3 E-01	1.1 E-01	4.3 E-01	8.0 E-04	1.3 E-02
1990	4.4 E-02	1.1 E-01	6.5 E-01	5.2 E-04	1.1 E-02
1991	4.9 E-02	1.6 E-01	8.3 E-01	8.6 E-04	1.4 E-02

NR = Not Reported.

Table H-6. Average Radionuclide Concentrations (pCi/g) Detected in 100-H Area Surface Soil Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	1.5 E-01	NR	9.0 E-02	NR	NR
1982	1.8 E-01	NR	3.4 E-01	NR	NR
1983	1.6 E-01	NR	4.7 E-01	NR	NR
1984	3.7 E-01	2.4 E-01	1.7 E+00	6.9 E-04	1.5 E-02
1985	1.4 E-01	9.8 E-02	2.3 E-01	1.9 E-04	5.7 E-03
1986	1.8 E-01	7.1 E-02	8.9 E-01	6.1 E-04	1.0 E-02
1987	2.8 E-01	1.9 E-01	2.0 E+00	8.5 E-04	3.1 E-02
1988	1.6 E-01	7.5 E-02	3.6 E-01	6.2 E-04	6.6 E-03
1989	2.0 E-01	5.0 E-02	5.3 E-01	9.2 E-04	6.5 E-03
1990	1.0 E-01	6.5 E-02	4.5 E-01	3.3 E-01	7.6 E-03
1991	7.8 E-02	8.1 E-02	1.6 E+00	6.0 E-04	1.9 E-02

NR = Not Reported.

Table H-7. Average Radionuclide Concentrations (pCi/g) Detected in 100-K Area Surface Soil Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	8.3 E-01	NR	4.4 E+00	NR	NR
1982	2.6 E+01	NR	8.8 E-01	NR	NR
1983	5.5 E+01	NR	5.3 E+01	NR	NR
1984	3.3 E+00	8.4 E-01	1.2 E+01	9.6 E-04	2.9 E-02
1985	7.4 E-01	2.9 E-01	1.1 E+00	1.4 E-03	3.2 E-02
1986	1.0 E+00	1.8 E-01	1.1 E+00	9.1 E-04	2.3 E-02
1987	1.2 E+00	4.3 E-01	1.3 E+00	2.7 E-03	5.5 E-02
1988	3.9 E-01	2.3 E-01	7.3 E-01	7.1 E-04	2.0 E-02
1989	7.7 E-01	6.3 E-01	7.5 E+00	2.8 E-03	7.8 E-02
1990	2.3 E-01	2.3 E-01	9.7 E-01	6.8 E-04	1.4 E-02
1991	2.7 E-01	1.7 E-01	1.2 E+00	8.6 E-04	2.0 E-02

NR = Not Reported.

Table H-8. 200/600 Area Soils. (pCi/g)

	^{137}Cs		^{90}Sr		$^{239/240}Pu$		^{234}U		^{235}U		^{238}U	
Maximum	89	Site ID 30	6.1	Site ID 34	1.0	Site ID 32	1.7	Site ID 88	0.14	Site ID 89	1.6	Site ID 88
Average	5.1		0.7		0.1		0.7		0.03		0.7	
PNL Offsite average	0.43		0.09		0.007		1.5 total uranium					
Guide for posting surface contamination	20,000		600		75		100		15		50	

Table H-9. 300/400 Area Soil Sample. (pCi/g)

	^{137}Cs		^{90}Sr		$^{239/240}Pu$		^{234}U		^{235}U		^{238}U	
Maximum	0.51	Site ID S-7	0.21	Site ID S-8	0.15	Site ID S-4	20	Site ID S-4	0.88	Site ID S-4	20	Site ID S-4
Average	0.18		0.06		0.02		3.1		0.16		2.9	
PNL East Perimeter site average	0.43		0.09		0.007				1.5 uranium total			
Guide for posting surface contamination	20,000		600		75		100		15		50	

Table H-10. Average Radionuclide Concentrations (pCi/g) Detected in Vegetation Samples near the 1301-N Liquid Waste Disposal Facility from 1980 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1980	4.0 E+00	NR	1.1 E+00	NR	NR
1981	1.2 E+01	1.8 E+00	1.8 E+00	NR	7.1 E-03
1982	1.6 E+00	1.2 E-01	2.6 E-01	NR	2.6 E-03
1983	1.9 E+00	6.0 E-01	3.9 E-01	NR	3.2 E-03
1984	1.0 E+00	1.2 E-01	8.3 E-02	NR	8.5 E-04
1985	1.7 E+00	1.9 E+00	1.0 E-01	NR	1.5 E-03
1986	3.5 E+00	7.3 E-02	6.5 E-01	NR	2.6 E-03
1987	2.8 E+00	6.3 E-02	2.0 E-01	1.2 E-03	5.6 E-03
1988	2.0 E+00	1.2 E-01	1.3 E-01	4.3 E-04	1.7 E-03
1989	1.3 E+00	3.8 E-02	1.5 E-01	2.8 E-04	2.0 E-03
1990	1.3 E+00	3.1 E-02	1.2 E-01	2.7 E-04	1.1 E-03
1991	6.3 E-01	1.5 E-02	6.0 E-05	8.1 E-05	1.2 E-03

NR = Not reported.

Table H-11. Average Radionuclide Concentrations (pCi/g) Detected in 100-N Vegetation Samples from 1980 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1980	1.0 E+00	NR	2.8 E-01	NR	NR
1981	2.5 E+01	5.8 E-01	7.1 E-01	NR	2.1 E-02
1982	1.5 E+00	2.0 E-01	1.3 E-01	NR	7.8 E-03
1983	1.0 E+00	2.9 E-01	9.0 E-02	NR	8.6 E-03
1984	4.6 E-01	8.1 E-02	9.0 E-02	NR	1.3 E-03
1985	1.4 E+00	5.1 E-02	1.6 E-01	NR	8.7 E-04
1986	9.5 E-01	2.2 E-01	7.9 E-01	NR	1.1 E-03
1987	7.0 E-01	2.6 E-01	9.4 E-02	1.3 E-04	5.7 E-04
1988	8.0 E-01	2.5 E-01	1.6 E-01	1.7 E-04	6.6 E-04
1989	3.2 E-01	6.8 E-02	1.5 E-01	1.1 E-04	8.7 E-04
1990	1.1 E-01	9.3 E-03	3.6 E-02	<9.6 E-05	1.7 E-04
1991	1.3 E-01	9.4 E-03	3.4 E-03	1.6 E-04	2.5 E-03

NR = Not reported.

Table H-12. Radionuclide Concentrations (pCi/g) Detected in N-Springs Vegetation Samples from 1980 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1980	5.6 E+00	NR	4.4 E-01	NR	NR
1981	3.3 E+00	2.0 E+02	NR	NR	3.7 E-03
1982	2.8 E+00	4.8 E+02	NR	NR	8.3 E-03
1983	3.0 E+00	3.3 E+02	4.0 E-02	NR	8.0 E-03
1984	NR	NR	NR	NR	NR
1985	1.2 E+00	4.2 E+02	1.7 E-01	NR	4.4 E-04
1986	1.1 E+00	2.2 E+02	2.1 E-01	NR	4.2 E-04
1987	9.0 E-01	2.9 E+02	1.1 E-01	<1.3 E-04	7.6 E-04
1988	1.4 E+00	1.2 E+02	2.0 E-01	8.5 E-05	2.0 E-04
1989	4.3 E-01	8.0 E+01	1.5 E-01	1.1 E-03	4.5 E-04
1990	NS	NS	NS	NS	NS
1991	1.5 E-01	3.1 E+01	1.6 E-01	1.2 E-04	2.9 E-03

NR = Not reported.
NS = No sample results.

Table H-13. Average Radionuclide Concentrations (pCi/g) Detected in 100-B/C Area Vegetation Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	3.6 E+00	NR	3.6 E-01	NR	NR
1982	1.9 E-01	NR	1.1 E-01	NR	NR
1983	1.8 E-01	NR	8.0 E-02	NR	NR
1984	1.3 E-01	1.4 E+00	8.7 E-02	2.4 E-04	6.0 E-04
1985	4.6 E-01	1.4 E+00	1.2 E-01	2.5 E-04	1.0 E-03
1986	2.5 E-01	2.0 E-01	2.8 E+00	2.5 E-05	6.2 E-04
1987	1.5 E-01	2.3 E-01	1.0 E-01	4.6 E-04	6.5 E-04
1988	3.5 E-01	2.6 E-01	2.1 E-01	1.4 E-04	3.1 E-04
1989	3.2 E-01	1.6 E-01	1.8 E-01	6.5 E-05	2.4 E-04
1990	4.5 E-02	9.1 E-02	6.7 E-02	<2.5 E-05	3.0 E-04
1991	5.7 E-02	8.3 E-02	1.8 E-01	2.9 E-05	1.1 E-03

NR = Not reported.

Table H-14. Average Radionuclide Concentrations (pCi/g) Detected in 100-D/DR Area Vegetation Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	1.2 E+00	NR	1.6 E-01	NR	NR
1982	1.1 E-01	NR	2.7 E+00	NR	NR
1983	9.5 E-02	NR	1.4 E-01	NR	NR
1984	2.1 E-01	2.8 E-01	1.7 E+00	1.8 E-03	5.8 E-04
1985	2.4 E-01	6.9 E-02	6.8 E-01	1.2 E-04	7.0 E-04
1986	2.7 E-01	1.5 E-01	1.7 E+00	0.0	3.1 E-04
1987	2.5 E-01	9.5 E-02	6.3 E-01	1.6 E-04	2.8 E-04
1988	2.8 E-01	1.8 E-01	9.6 E-02	3.8 E-05	1.9 E-04
1989	2.6 E-01	1.5 E-01	2.8 E-01	9.6 E-05	1.2 E-04
1990	6.1 E-02	9.5 E-02	6.2 E-01	<2.4 E-05	2.6 E-04
1991	5.7 E-02	8.3 E-02	1.8 E-01	2.9 E-05	1.1 E-03

NR = Not reported.

Table H-15. Average Radionuclide Concentrations (pCi/g) Detected in 100-F Area Vegetation Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	9.2 E-01	NR	2.2 E+00	NR	NR
1982	1.6 E-01	NR	7.9 E-01	NR	NR
1983	2.8 E-01	NR	1.0 E+00	NR	NR
1984	2.2 E+00	7.6 E+00	2.0 E+01	4.9 E-04	3.9 E-03
1985	3.3 E-01	1.4 E+00	5.8 E-01	4.9 E-05	5.3 E-04
1986	1.7 E-01	9.3 E-02	1.1 E+00	8.3 E-05	1.2 E-04
1987	2.4 E-01	1.8 E-01	1.8 E-01	3.8 E-04	1.7 E-04
1988	9.9 E-01	8.9 E-02	3.1 E-01	3.3 E-05	1.1 E-04
1989	2.8 E-01	9.6 E-02	2.0 E+00	5.2 E-05	1.4 E-04
1990	5.0 E-02	2.7 E-01	4.2 E-01	<4.9 E-05	3.6 E-04
1991	8.2 E-02	2.9 E-01	3.8 E-01	2.9 E-05	7.0 E-03

NR = Not reported.

Table H-16. Average Radionuclide Concentrations (pCi/g) Detected in 100-H Area Vegetation Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	6.8 E-01	NR	1.5 E-01	NR	NR
1982	NR	NR	NR	NR	NR
1983	1.3 E-01	NR	9.0 E-02	NR	NR
1984	1.8 E-01	2.0 E+00	1.3 E-01	2.0 E-04	1.7 E-03
1985	2.0 E-01	6.0 E-02	4.5 E-02	1.0 E-04	5.1 E-04
1986	2.2 E-01	5.3 E-01	1.3 E+00	1.3 E-04	4.4 E-05
1987	2.6 E-01	2.6 E-01	1.0 E-01	3.5 E-05	2.7 E-04
1988	9.0 E-01	3.9 E-01	1.5 E-01	2.0 E-04	1.5 E-04
1989	6.5 E-01	5.2 E-02	2.1 E-01	8.5 E-05	1.5 E-04
1990	<1.3 E-01	1.1 E-02	6.6 E-02	<1.4 E-04	3.0 E-04
1991	<2.8 E-02	5.7 E-02	3.0 E-02	4.5 E-05	5.7 E-04

NR = Not reported.

Table H-17. Average Radionuclide Concentrations (pCi/g) Detected in 100-K Area Vegetation Samples from 1981 to 1991.

Year	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
1981	1.2 E+00	NR	1.0 E-01	NR	NR
1982	2.4 E-01	NR	9.7 E-01	NR	NR
1983	1.5 E-01	NR	2.5 E-01	NR	NR
1984	1.8 E-01	1.3 E+00	1.3 E-01	2.9 E-04	6.9 E-04
1985	4.6 E-01	3.9 E-01	1.3 E-01	1.9 E-04	7.1 E-04
1986	2.8 E-01	4.0 E-01	1.5 E+00	2.5 E-04	7.9 E-04
1987	2.3 E-01	1.3 E+00	1.1 E-01	1.9 E-04	2.2 E-04
1988	4.9 E-01	1.2 E+00	1.8 E-01	5.2 E-05	3.8 E-04
1989	3.1 E-01	1.3 E+00	1.6 E-01	1.1 E-04	1.5 E-04
1990	4.5 E-02	8.0 E+00	4.1 E-02	<1.7 E-04	2.5 E-04
1991	6.3 E-02	4.1 E-01	7.6 E-02	5.2 E-05	5.9 E-04

NR = Not reported.

Table H-18. 200 Area Vegetation (pCi/g).

	^{137}Cs		^{90}Sr		$^{239/240}Pu$		^{234}U		^{235}U		^{238}U	
Maximum	3.0	Site ID 34	4.1	Site ID 99	0.05	Site ID 2	0.15	Site ID 92	0.005	Site ID 55	0.04	Site ID 55
Average	0.4		0.3		0.004		0.007		0.0006		0.014	
PNL Offsite average	0.026		0.063		0.003		0.034 total uranium					
Guide for posting surface contamination	20,000		600		75		100		15		50	

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APPENDIX I

PLANT SPECIES OBSERVED AT 100 AREAS OPERABLE UNITS

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Figure I-1. 100 Areas Operable Units.

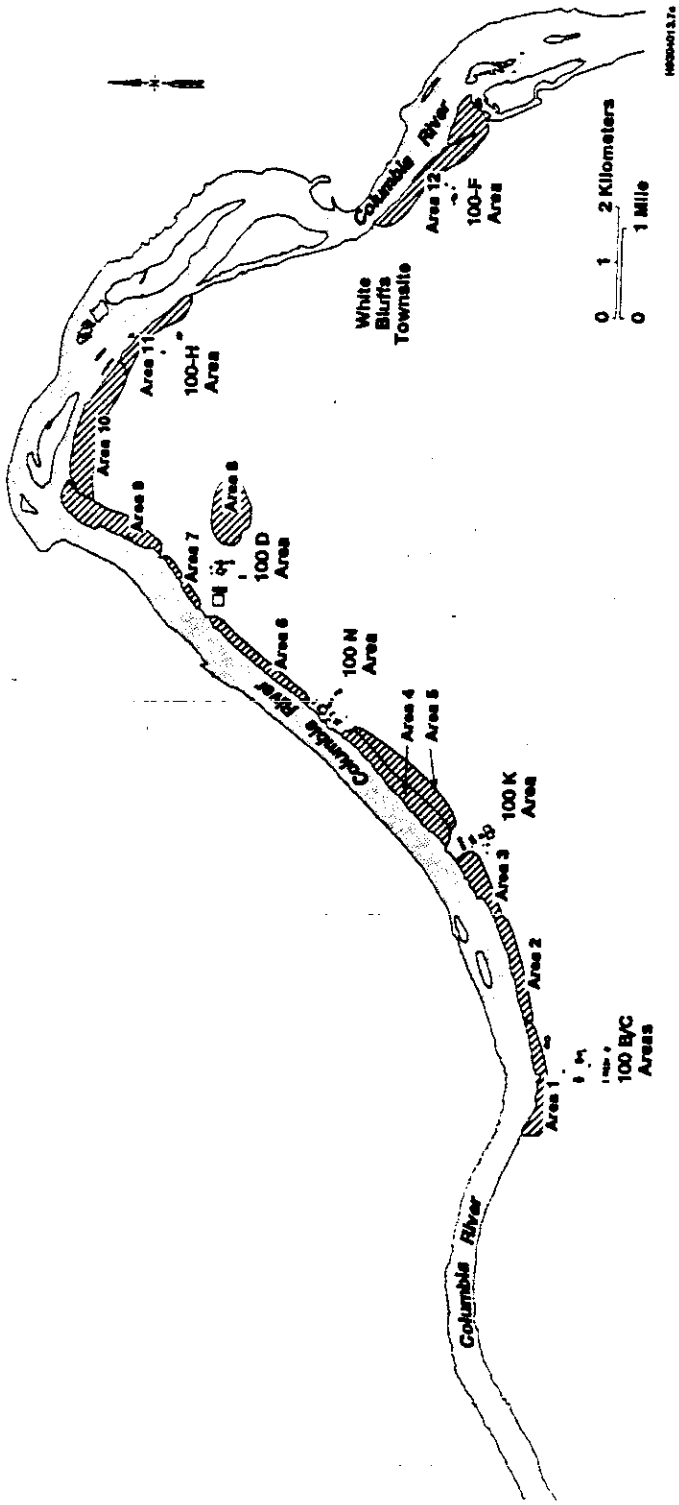

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Table I-1. Species Observed in Vicinity of 100-BC Area. (sheet 1 of 2)

Species	Family	Common name
Achillea millefolium	Asteraceae	yarrow
Artemisia campestris	Asteraceae	Pacific sage
Artemisia ludoviciana	Asteraceae	prairie sagebrush
Artemisia tridentata	Asteraceae	big sagebrush
Aster hesperius	Asteraceae	western marsh aster
Chrysothamnus nauseosus	Asteraceae	gray rabbitbrush
Centaurea repens	Asteraceae	Russian knapweed
Cirsium arvense	Asteraceae	Canada thistle
Coreopsis atkinsoniana	Asteraceae	Columbia tickseed
Gaillardia aristata	Asteraceae	blanket flower
Gnaphalium palustre	Asteraceae	lowland cudweed
Grindelia columbiana	Asteraceae	Columbia River gumweed
Helenium autumnale	Asteraceae	sneezeweed
Solidago canadensis	Asteraceae	meadow goldenrod
Solidago occidentalis	Asteraceae	western goldenrod
Xanthium strumarium	Asteraceae	cocklebur
Amsinckia lycopsoides	Boraginaceae	fiddleneck
Descurainia pinnata	Brassicaceae	western tansymustard
Descurainia sophia	Brassicaceae	flixweed
Lepidium perfoliatum	Brassicaceae	clasping pepperweed
Lesquerella douglasii	Brassicaceae	Columbia bladderpod
Rorippa columbiae	Brassicaceae	Columbia yellowcress
Sisymbrium altissimum	Brassicaceae	Jim Hill's tumblemustard
Cerastium viscosum	Caryophyllaceae	sticky chickweed
Juniperus scopulorum	Cupressaceae	Rocky Mountain juniper
Carex douglasii	Cyperaceae	Douglas' sedge
Carex densa	Cyperaceae	Dense sedge
Carex lenticularis	Cyperaceae	Kellogg's sedge
Glycyrrhiza lepidota	Fabaceae	licorice

Table I-1. Species Observed in Vicinity of 100-BC Area. (sheet 2 of 2)

Species	Family	Common name
Melilotus alba	Fabaceae	white sweetclover
Lupinus wyethii	Fabaceae	Wyeth's lupine
Erodium cicutarium	Geraniaceae	storksbill
Hypericum perforatum	Hypericaceae	Klamath weed
Juncus balticus	Juncaceae	Baltic rush
Juncus spp.	Juncaceae	rush
Sphaeralcea munroana	Malvaceae	Munro's globemallow
Morus alba	Moraceae	white mulberry
Epilobium watsonii	Onagraceae	Watson's willow herb
Oenothera strigosa	Onagraceae	common evening primrose
Agropyron dasytachyum	Poaceae	thickspike wheatgrass
Agrostis alba	Poaceae	redtop bentgrass
Bromus tectorum	Poaceae	cheatgrass
Phalaris arundinacea	Poaceae	Reed canarygrass
Poa sandbergii	Poaceae	Sandberg's bluegrass
Sitanion hystrix	Poaceae	bottlebrush grass
Sporobolus cryptandrus	Poaceae	sand dropseed
Polygonum persicaria	Polygonaceae	heartweed
Potentilla anserina	Rosaceae	common silverweed
Salix spp.	Salicaceae	willow
Gratiola neglecta	Scrophulariaceae	American hedge-hyssop
Verbascum thapsus	Scrophulariaceae	common mullein
Collinsia parviflora	Scrophulariaceae	small blue-eyed Mary
Limosella aquatic (acaulis)	Scrophulariaceae	southern mudwort
Lindernia anagallidea	Scrophulariaceae	false pimpernel
Veronica peregina	Scrophulariaceae	purslane speedwell
Ulmus pumila	Ulmaceae	Siberian elm
Verbena bracteata	Verbenaceae	bracted verbena

spp. = species, more than one.

Table I-2. Species Observed along Shoreline between 100-B and Allard Pumphouse. (sheet 1 of 2)

Species	Family	Common name
Apocynum cannabinum	Apocynaceae	Common dogbane
Asclepias speciosa	Asclepiadaceae	Showy milkweed
Achillea millefolium	Asteraceae	Yarrow
Antennaria umbrinella	Asteraceae	Umber pussytoes
Artemisia campestris	Asteraceae	Pacific sage
Artemisia lindleyana	Asteraceae	Columbia River mugwort
Artemisia ludoviciana	Asteraceae	Prairie sage
Artemisia tridentata	Asteraceae	Big sagebrush
Aster hesperius	Asteraceae	Western marsh aster
Centaurea diffusa	Asteraceae	Diffuse knapweed
Centaurea repens	Asteraceae	Russian knapweed
Cichorium intybus	Asteraceae	Chicory
Chrysothamnus nauseosus	Asteraceae	Gray rabbitbrush
Coreopsis atkinsoniana	Asteraceae	Tickseed
Gaillardia aristata	Asteraceae	Blanketflower
Grindelia columbiana	Asteraceae	Columbia River gumweed
Helenium autumnale	Asteraceae	Sneezeweed
Rorippa islandica	Brassicaceae	Western yellowcress
Rorippa obtusa	Brassicaceae	Blunt leaf yellowcress
Sisymbrium altissimum	Brassicaceae	Jim Hill Mustard
Dianthus armeria	Caryophyllaceae	Grass pink
Salsola kali	Chenopodiaceae	Russian thistle
Convolvulus arvensis	Convolvulaceae	Field bindweed
Carex densa	Cyperaceae	Dense sedge
Carex sp.	Cyperaceae	Sedge
Eleocharis palustris	Cyperaceae	Common spikerush
Melilotus alba	Fabaceae	White sweetclover
Trifolium repens	Fabaceae	white clover
Hypericum perforatum	Hypericaceae	St. Johnswort

Table I-2. Species Observed along Shoreline between 100-B and Allard Pumphouse. (sheet 2 of 2)

Species	Family	Common name
Allium ssp.	Liliaceae	Onion
Asparagus officinale	Liliaceae	Asparagus
Lythrum salicaria	Lythraceae	Purple loosestrife
Morus alba	Moraceae	Mulberry
Epilobium watsonii	Onagraceae	Watson's willowherb
Plantago lanceolata	Plantaginaceae	English plantain
Plantago major	Plantaginaceae	Common plantain
Agropyron dasytachyum	Poaceae	Thickspike wheatgrass
Agrostis scabrella	Poaceae	ticklegrass
Bromus tectorum	Poaceae	Cheatgrass
Phalaris arundinacea	Poaceae	Reed canarygrass
Poa pratensis	Poaceae	Kentucky bluegrass
Sporobolus cryptandrus	Poaceae	Sand dropseed
Polygonum persicaria	Polygonaceae	Doorweed
Rumex salicifolius	Polygonaceae	Willow dock
Ranunculus flammula	Ranunculaceae	Creeping buttercup
Salix exigua	Salicaceae	Coyote willow
Verbascum thapsus	Scrophulariaceae	Wooly mullein
Ulmus pumila	Ulmaceae	Siberian elm
Verbena bracteata	Verbenaceae	Bracted verbena
Verbena hastata	Verbenaceae	Blue verbena

spp. = species, more than one.

Table I-3. Species Observed between Allard Pumphouse and 100-K Area.
(sheet 1 of 4)

Species	Family	Common name
Lomatium canbyi	Apiaceae	Canby's Desertparsley
Lomatium grayi	Apiaceae	Gray's Desertparsley
Apocynum cannabinum	Apocynaceae	Common dogbane
Asclepias speciosa	Asclepiadaceae	Showy milkweed
Achillea millefolium	Asteraceae	Yarrow
Antennaria umbrinella	Asteraceae	Umber pussytoes
Artemisia campestris	Asteraceae	Pacific Sage
Artemisia lindleyana	Asteraceae	Columbia river mugwort
Artemisia ludoviciana	Asteraceae	Prairie Sage
Artemisia tridentata	Asteraceae	Big sagebrush
Aster hesperius	Asteraceae	Western marsh aster
Centaurea diffusa	Asteraceae	Diffuse knapweed
Cichorium intybus	Asteraceae	Chicory
Chrysothamnus nauseosus	Asteraceae	Gray rabbitbrush
Cirsium arvense	Asteraceae	Canada thistle
Conyza canadensis	Asteraceae	Horseweed
Coreopsis atkinsoniana	Asteraceae	Columbia tickseed
Gaillardia aristata	Asteraceae	Blanketflower
Grindelia columbiana	Asteraceae	Columbia river gumweed
Helenium autumnale	Asteraceae	Sneezeweed
Lactuca serriola	Asteraceae	Prickly lettuce
Solidago graminifolia	Asteraceae	Bushy goldenrod
Solidago ssp.	Asteraceae	goldenrod
Taraxacum officinale	Asteraceae	Dandelion
Tragopogon dubius	Asteraceae	Salsify
Xanthium strumarium	Asteraceae	Cocklebur
Amsinckia lycopsoides	Boraginaceae	Tarweed fiddleneck
Myosotis laxa	Boraginaceae	Small forget-me-not
Cardamine pennsylvanica	Brassicaceae	Pennsylvania bittercress

Table I-3. Species Observed between Allard Pumphouse and 100-K Area.
(sheet 2 of 4)

Species	Family	Common name
Descurainia pinnata	Brassicaceae	Tansymustard
Draba verna	Brassicaceae	Spring whitlowgrass
Lepidium perfoliatum	Brassicaceae	Clasping pepperweed
Rorippa curvisiliqua	Brassicaceae	Western yellowcress
Rorippa islandica	Brassicaceae	Marsh yellowcress
Rorippa obtusa	Brassicaceae	Bluntleaf yellowcress
Sisymbrium altissimum	Brassicaceae	Jim Hill mustard
Cerastium vulgatum	Caryophyllaceae	Common chickweed
Dianthus armeria	Caryophyllaceae	Grass pink
Holosteum umbellatum	Caryophyllaceae	Jagged chickweed
Salsola kali	Chenopodiaceae	Russian thistle
Convolvulus arvensis	Convolvulaceae	Field bindweed
Juniperus scopulorum	Cupressaceae	Rocky Mountain juniper
Carex aperta	Cyperaceae	Columbia sedge
Carex densa	Cyperaceae	Dense sedge
Carex ssp.	Cyperaceae	sedges
Eleocharis palustris	Cyperaceae	Common spikerush
Scirpus americanus	Cyperaceae	Threesquare bulrush
Equisetum ssp.	Equisetaceae	Horsetail
Lupinus wyethii	Fabaceae	Wyeth's lupine
Melilotus alba	Fabaceae	White sweetclover
Psoralea lanceolata	Fabaceae	Dune scurfpea
Robinia psuedo-acacia	Fabaceae	Black Locust
Trifolium repens	Fabaceae	White clover
Erodium cicutarium	Geraniaceae	Cranes bill
Myriophyllum spicatum	Haloragaceae	Spiked water milfoil
Hypericum perfoliatum	Hypericaceae	St. Johnswort
Iris missouriensis	Iridaceae	Western blueflag

Table I-3. Species Observed between Allard Pumphouse and 100-K Area. (sheet 3 of 4)

Species	Family	Common name
Juncus articulatus	Juncaceae	Jointed rush
Juncus balticus	Juncaceae	Baltic rush
Juncus tenuis	Juncaceae	Slender rush
Triglochin palustre	Juncaginaceae	March arrowgrass
Allium cernuum	Liliaceae	Nodding onion
Allium robinsonii	Liliaceae	Robinson's onion
Allium schoenoprasum	Liliaceae	Chives
Asparagus officinale	Liliaceae	Asparagus
Lythrum salicaria	Lythraceae	Purple Loosestrife
Sphaeralcea munroana	Malvaceae	Globemallow
Morus alba	Moraceae	Mulberry
Epilobium watsonii	Onagraceae	watson's willowherb
Plantago lanceolata	Plantaginaceae	English plantain
Plantago major	Plantaginaceae	Common plantain
Agropyron dasytachyum	Poaceae	Thickspike wheatgrass
Agrostis scabra	Poaceae	Ticklegrass
Bromus tectorum	Poaceae	Cheatgrass
Festuca arundinacea	Poaceae	Tall fescue
Phalaris arundinacea	Poaceae	Reed canarygrass
Poa bulbifera	Poaceae	Bulbous bluegrass
Poa nevadensis	Poaceae	Nevada bluegrass
Poa pratensis	Poaceae	Kentucky bluegrass
Poa sandbergii	Poaceae	Sandberg's bluegrass
Sporobolus cryptandrus	Poaceae	Sand dropseed
Collomia linearis	Polemoniaceae	Narrowleaf collomia
Phlox longifolia	Polemoniaceae	Longleaf phlox
Polygonum persicaria	Polygonaceae	Heartweed
Polygonum amphibium	Polygonaceae	Water smartweed

Table I-3. Species Observed between Allard Pumphouse and 100-K Area.
(sheet 4 of 4)

Species	Family	Common name
Rumex salicifolius	Polygonaceae	Willow dock
Montia perfoliata	Portulacaceae	Miner's lettuce
Delphinium nuttallianum	Ranunculaceae	Upland larkspur
Potentilla rivalis	Rosaceae	Brook cinquefoil
Gallium aparine	Rubiaceae	Cleavers
Salix exigua	Salicaceae	Coyote willow
Verbascum thapsus	Scrophulariaceae	Wooly mullein
Veronica anagallis-aquatica	Scrophulariaceae	water speedwell
Ulmus pumila	Ulmaceae	Siberian Elm
Verbena bracteata	Verbenaceae	Bracted verbena
Verbena hastata	Verbenaceae	Blue verbena

Table I-4. Species Observed along Shoreline between 100-K and 100-N Areas. (sheet 1 of 3)

Species	Family	Common name
Lomatium grayi	Apiaceae	Gray's desert-parsley
Apocynum cannabinum	Apocynaceae	Common dogbane
Asclepias speciosa	Asclepiadaceae	Showy milkweed
Achillea millefolium	Asteraceae	Yarrow
Antennaria umbrinella	Asteraceae	Umber pussytoes
Artemisia campestris	Asteraceae	Pacific sage
Artemisia lindleyana	Asteraceae	Columbia river mugwort
Artemisia ludoviciana	Asteraceae	Prairie sage
Aster hesperius	Asteraceae	Western marsh aster
Centaurea diffusa	Asteraceae	Diffuse knapweed
Cichorium intybus	Asteraceae	Chicory
Cirsium vulgare	Asteraceae	Bull thistle
Conyza canadensis	Asteraceae	Horseweed
Coreopsis atkinsoniana	Asteraceae	Tickseed
Gnaphalium palustre	Asteraceae	Lowland cudweed
Helenium autumnale	Asteraceae	Sneezeweed
Lactuca serriola	Asteraceae	Prickly lettuce
Solidago graminifolia	Asteraceae	Bushy goldenrod
Tragopogon dubius	Asteraceae	Salsify
Xanthium strumarium	Asteraceae	Cocklebur
Amsinckia lycopsoides	Boraginaceae	Tarweed fiddleneck
Myosotis micrantha	Boraginaceae	Blue forget-me-not
Myosotis laxa	Boraginaceae	Small forget-me-not
Cardamine pennsylvanica	Brassicaceae	Pennsylvania bittercress
Draba verna	Brassicaceae	Spring whitlowgrass
Rorippa columbiae	Brassicaceae	Columbia yellowcress
Rorippa curvisiliqua	Brassicaceae	Western yellowcress
Rorippa islandica	Brassicaceae	Marsh yellowcress
Rorippa obtusa	Brassicaceae	Blunt leaf Yellowcress

Table I-4. Species Observed along Shoreline between 100-K and 100-N Areas. (sheet 2 of 3)

Species	Family	Common name
Sisymbrium altissimum	Brassicaceae	Jim Hill Mustard
Cerastium vulgatum	Caryophyllaceae	Common chickweed
Dianthus armeria	Caryophyllaceae	Grass pink
Holosteum umbellatum	Caryophyllaceae	Jagged chickweed
Convolvulus arvensis	Convolvulaceae	Field bindweed
Juniperus scopulorum	Cupressaceae	Rocky mt. juniper
Carex aperta	Cyperaceae	Columbia sedge
Carex athrostachya	Cyperaceae	Slenderbeak sedge
Carex densa	Cyperaceae	Dense sedge
Carex douglasii	Cyperaceae	Douglas' sedge
Carex lenticularis	Cyperaceae	Kellogg sedge
Eleocharis palustris	Cyperaceae	Common spikerush
Equisetum hyemale	Equisetaceae	Dutch horsetail
Lotus purshiana	Fabaceae	Spanish clover
Lupinus lepidus	Fabaceae	Prairie lupine
Medicago lupulina	Fabaceae	Black medick
Melilotus alba	Fabaceae	White sweetclover
Trifolium repens	Fabaceae	White clover
Erodium cicutarium	Geraniaceae	Crane's bill
Hypericum perforatum	Hypericaceae	St. Johnswort
Juncus balticus	Juncaceae	Baltic rush
Juncus tenuis	Juncaceae	Slender rush
Triglochin palustre	Juncaginaceae	Marsh arrowgrass
Lycopus americanus	Lamiaceae	Cutleaf water-horehound
Mentha arvensis	Lamiaceae	Field mint
Allium schoenoprasum	Liliaceae	Chives
Asparagus officinalis	Liliaceae	Asparagus
Marsilea vestita	Marsileaceae	Clover fern
Morus alba	Moraceae	Mulberry

Table I-4. Species Observed along Shoreline between 100-K and 100-N Areas. (sheet 3 of 3)

Species	Family	Common name
Epilobium watsonii	Onagraceae	Watson's willowherb
Oenothera strigosa	Onagraceae	Common eveningprimrose
Plantago lanceolata	Plantaginaceae	English plantain
Plantago major	Plantaginaceae	Common plantain
Agropyron dasytachyum	Poaceae	Thickspike wheatgrass
Agrostis scabra	Poaceae	Ticklegrass
Bromus tectorum	Poaceae	Cheatgrass
Panicum capillare	Poaceae	Common witchgrass
Phalaris arundinacea	Poaceae	Reed canarygrass
Poa bulbosa	Poaceae	Bulbous bluegrass
Poa pratensis	Poaceae	Kentucky bluegrass
Poa sandbergii	Poaceae	Sandberg's bluegrass
Poa scabrella	Poaceae	Pine bluegrass
Polygonum aviculare	Polygonaceae	doorweed
Rumex salicifolius	Polygonaceae	Willow dock
Montia perfoliata	Portulacaceae	Miner's lettuce
Ranunculus flammula	Ranunculaceae	Creeping buttercup
Potentilla rivalis	Rosaceae	Brook cinquefoil
Salix exigua	Salicaceae	Coyote willow
Gratiola neglecta	Scrophulariaceae	American hedge-hyssop
Limosella acaulis	Scrophulariaceae	Southern mudwort
Verbascum thapsus	Scrophulariaceae	Wooly mullein
Veronica americana	Scrophulariaceae	Brooklime
Veronica anagallis-aquatica	Scrophulariaceae	Water speedwell
Veronica peregrina	Scrophulariaceae	Purslane speedwell
Ulmus pumila	Ulmaceae	Siberian elm
Verbena bracteata	Verbenaceae	Bracted verbena

Table I-5. Species Observed in Dryland Area above Shoreline between 100-K and 100-N Areas.

Species	Family	Common name
Achillea millefolium	Asteraceae	Yarrow
Agoseris heterophylla	Asteraceae	Annual mountain dandelion
Ambrosia acanthicarpa	Asteraceae	Bur ragweed
Artemisia campestris	Asteraceae	Pacific sage
Artemisia tridentata	Asteraceae	Big sagebrush
Centaurea diffusa	Asteraceae	Diffuse knapweed
Cirsium arvense	Asteraceae	Canada thistle
Chrysothamnus nauseosus	Asteraceae	Gray rabbitbrush
Chrysothamnus viscidiflorus	Asteraceae	Green rabbitbrush
Erigeron pumilus	Asteraceae	Shaggy fleabane
Machaeranthera canescens	Asteraceae	Hoary aster
Solidago sp.	Asteraceae	Goldenrod
Amsinckia lycopsoides	Boraginaceae	Tarweed fiddleneck
Amsinckia tessellata	Boraginaceae	Tessellate fiddleneck
Descurainia pinnata	Brassicaceae	Tansymustard
Lepidium perfoliatum	Brassicaceae	Clasping pepperweed
Lepidium virginicum	Brassicaceae	Tall pepperweed
Sisymbrium altissimum	Brassicaceae	Jim Hill Mustard
Holosteum umbellatum	Caryophyllaceae	Jagged chickweed
Sphaeralcea munroana	Malvaceae	Globemallow
Agropyron dasytachyum	Poaceae	Thickspike wheatgrass
Bromus tectorum	Poaceae	Cheatgrass
Elymus cinereus	Poaceae	Wildrye
Poa sandbergii	Poaceae	Sandberg's bluegrass
Sporobolus cryptandrus	Poaceae	Sand Dropseed

Table I-6. Species Observed along Shoreline between 100-N and 100-D Areas. (sheet 1 of 3)

Species	Family	Common name
Lomatium grayi	Apiaceae	Gray's desertparsley
Apocynum cannabinum	Apocynaceae	Common Dogbane
Asclepias speciosa	Asclepiadaceae	Showy milkweed
Achillea millefolium	Asteraceae	Yarrow
Artemisia campestris	Asteraceae	Pacific sage
Artemisia lindleyana	Asteraceae	Columbia river mugwort
Artemisia ludoviciana	Asteraceae	Prairie sage
Artemisia tridentata	Asteraceae	Big Sagebrush
Aster occidentalis	Asteraceae	Western mountain aster
Centaurea diffusa	Asteraceae	Diffuse Knapweed
Cirsium arvense	Asteraceae	Canada thistle
Chrysothamnus nauseosus	Asteraceae	Gray rabbitbrush
Coreopsis atkinsoniana	Asteraceae	Tickseed
Gaillardia aristata	Asteraceae	Blanket flower
Solidago graminifolia	Asteraceae	Bushy goldenrod
Tragopogon dubius	Asteraceae	Salsify
Xanthium strumarium	Asteraceae	Cocklebur
Amsinckia lycopsoides	Boraginaceae	Tarweed fiddleneck
Amsinckia tessellata	Boraginaceae	Tessellate fiddleneck
Myosotis laxa	Boraginaceae	Small forget-me-not
Descurainia pinnata	Brassicaceae	Tansymustard
Draba verna	Brassicaceae	Spring whitlowgrass
Lepidium perfoliatum	Brassicaceae	Clasping pepperweed
Sisymbrium altissimum	Brassicaceae	Jim Hill mustard
Cerastium vulgatum	Caryophyllaceae	Common chickweed
Holosteum umbellatum	Caryophyllaceae	Jagged chickweed
Grayia spinosa	Chenopodiaceae	Spiny hopsage
Convolvulus arvensis	Convolvulaceae	Field bindweed
Carex densa	Cyperaceae	Dense sedge

Table I-6. Species Observed along Shoreline between 100-N and 100-D Areas. (sheet 2 of 3)

Species	Family	Common name
Carex lanuginosa	Cyperaceae	woolly sedge
Carex praegracilis	Cyperaceae	Clustered field sedge
Equisetum laevigatum	Equisetaceae	Smooth scouringrush
Lupinus wyethii	Fabaceae	Wyeth's lupine
Medicago lupulina	Fabaceae	Black medick
Medicago sativa	Fabaceae	Alfalfa
Allium robinsonii	Liliaceae	Robinson onion
Allium schoenoprasum	Liliaceae	Chives
Asparagus officinale	Liliaceae	Asparagus
Sphaeralcea munroana	Malvaceae	Globe mallow
Morus alba	Moraceae	Mulberry
Plantago lanceolata	Plantaginaceae	English plantain
Plantago major	Plantaginaceae	Common plantain
Plantago patagonica	Plantaginaceae	Indian wheat
Agropyron dasytachyum	Poaceae	Thickspike wheatgrass
Agropyron spicatum	Poaceae	Bluebunch wheatgrass
Agrostis scabra	Poaceae	Ticklegrass
Bromus tectorum	Poaceae	Cheatgrass
Festuca arundinacea	Poaceae	Tall fescue
Oryzopsis hymenoides	Poaceae	Indian ricegrass
Phalaris arundinacea	Poaceae	Reed canarygrass
Poa bulbosa	Poaceae	Bulbous bluegrass
Poa pratensis	Poaceae	Kentucky bluegrass
Sporobolus cryptandrus	Poaceae	Sand dropseed
Stipa comata	Poaceae	Needle-and-thread
Eriogonum niveum	Polygonaceae	Snow buckwheat
Rumex salicifolius	Polygonaceae	Willow dock
Montia perfoliata	Portulacaceae	Miner's lettuce
Potentilla rivalis	Rosaceae	Brook cinquefoil

Table I-6. Species Observed along Shoreline between 100-N and 100-D Areas. (sheet 3 of 3)

Species	Family	Common name
Rosa woodsii	Rosaceae	Woods's rose
Veronica anagallis-aquatica	Scrophulariaceae	Water speedwell
Veronica peregrina	Scrophulariaceae	Purslane speedwell
Verbascum thapsus	Scrophulariaceae	Woolly mullein
Lycium halimifolium	Solanaceae	Matrimony vine
Ulmus pumilus	Ulmaceae	Siberian elm

Table I-7. Species Observed at Gravel/Cobble Shelf below 100-D Area. (sheet 1 of 2)

Species	Family	Common name
Lomatium grayi	Apiaceae	Gray's desertparsley
Asclepias speciosa	Asclepiadaceae	showy milkweed
Achillea millefolium	Asteraceae	yarrow
Artemisia campestris	Asteraceae	Pacific sage
Artemisia ludoviciana	Asteraceae	prairie sagebrush
Centaurea diffusa	Asteraceae	tumble knapweed
Centaurea repens	Asteraceae	Russian knapweed
Chrysothamnus nauseosus	Asteraceae	gray rabbitbrush
Cirsium arvense	Asteraceae	Canada thistle
Erigeron linearis	Asteraceae	desert yellow daisy
Gaillardia aristata	Asteraceae	blanket flower
Lactuca serriola	Asteraceae	prickly lettuce
Taraxacum officinale	Asteraceae	dandelion
Tragopogon dubius	Asteraceae	yellow salsify
Sisymbrium altissimum	Brassicaceae	Jim Hill's tumblemustard
Salsola kali	Chenopodiaceae	Russian thistle
Convolvulus arvensis	Convolvulaceae	field bindweed
Elaeagnus angustifolia	Elaeagnaceae	Russian olive
Lupinus leucophyllus	Fabaceae	velvet lupine
Lupinus sericeus	Fabaceae	silky lupine
Lupinus wyethii	Fabaceae	Wyeth's lupine
Medicago lupulina	Fabaceae	black medick
Medicago sativa	Fabaceae	alfalfa
Erodium cicutarium	Geraniaceae	storksbill
Ribes aureum	Grossulariaceae	golden currant
Sphaeralcea munroana	Malvaceae	Munro's globemallow
Morus alba	Moraceae	white mulberry
Plantago lanceolata	Plantaginaceae	English plantain
Agropyron dasytachyum	Poaceae	thickspike wheatgrass

Table I-7. Species Observed at Gravel/Cobble Shelf below 100-D Area. (sheet 2 of 2)

Species	Family	Common name
Agrostis alba	Poaceae	redtop bentgrass
Bromus tectorum	Poaceae	cheatgrass
Festuca arundinacea	Poaceae	tall fescue
Oryzopsis hymenoides	Poaceae	indian ricegrass
Phalaris arundinacea	Poaceae	reed canarygrass
Poa pratensis	Poaceae	Kentucky bluegrass
Poa sandbergii	Poaceae	Sandberg's bluegrass
Sitanion hystrix	Poaceae	bottlebrush grass
Sporobolus cryptandrus	Poaceae	sand dropseed
Montia perfoliata	Portulacaceae	miner's lettuce
Verbascum thapsus	Scrophulariaceae	common mullein
Ulmus pumila	Ulmaceae	Siberian elm

Table I-8. Species Observed in Sandy Area East of 100-D Area.

Species	Family	Common name
Cymopteris terebinthinus	Apiaceae	turpentine springparsley
Achillea millefolium	Asteraceae	yarrow
Artemisia tridentata	Asteraceae	big sagebrush
Chrysothamnus nauseosus	Asteraceae	gray rabbitbrush
Chrysothamnus viscidiflorus	Asteraceae	green rabbitbrush
Cryptantha circumscissa	Boraginaceae	matted cryptantha
Cryptantha fendleri	Boraginaceae	Fendler's cryptantha
Cryptantha leucophaea	Boraginaceae	gray cryptantha
Cryptantha pterocarya	Boraginaceae	winged cryptantha
Erysimum asperum	Brassicaceae	rough wallflower
Opuntia fragilis	Cactaceae	brittle pricklypear
Astragalus caricinus	Fabaceae	buckwheat milkvetch
Astragalus sclerocarpus	Fabaceae	stalked-pod milkvetch
Psoralea lanceolata	Fabaceae	dune scurfpea
Phacelia hastata	Hydrophyllaceae	whiteleaf scorpionweed
Phacelia linearis	Hydrophyllaceae	threadleaf scorpionweed
Sphaeralcea munroana	Malvaceae	Munro's globemallow
Bromus tectorum	Poaceae	cheatgrass
Oryzopsis hymenoides	Poaceae	indian ricegrass
Sitanion hystrix	Poaceae	bottlebrush grass
Stipa comata	Poaceae	needle-and-thread grass
Phlox longifolia	Polemoniaceae	longleaf phlox

Table I-9. Species Observed Downstream from 100-D Area, Boat Launch to River Mile 375. (sheet 1 of 2)

Species	Family	Common name
Lomatium grayi	Apiaceae	Gray's desertparsley
Lomatium macrocarpum	Apiaceae	large-fruited lomatium
Asclepias speciosa	Asclepiadaceae	showy milkweed
Achillea millefolium	Asteraceae	yarrow
Artemisia campestris	Asteraceae	Pacific sage
Artemisia tridentata	Asteraceae	big sagebrush
Centaurea diffusa	Asteraceae	diffuse knapweed
Chrysothamnus nauseosus	Asteraceae	gray rabbitbrush
Cirsium arvense	Asteraceae	Canada thistle
Coreopsis atkinsoniana	Asteraceae	Columbia tickseed
Erigeron pumilus	Asteraceae	shaggy fleabane
Tragopogon dubius	Asteraceae	yellow salsify
Xanthium strumarium	Asteraceae	cocklebur
Amsinckia lycopsoides	Boraginaceae	fiddleneck
Myosotis micrantha	Boraginaceae	blue forget-me-not
Descurainia pinnata	Brassicaceae	western tansymustard
Draba verna	Brassicaceae	spring whitlowgrass
Lepidium perfoliatum	Brassicaceae	clasping pepperweed
Lepidium virginicum	Brassicaceae	tall pepperweed
Lesquerella douglasii	Brassicaceae	Columbia bladderpod
Rorippa curvisiliqua	Brassicaceae	western yellowcress
Sisymbrium altissimum	Brassicaceae	Jim Hill's tumblemustard
Cerastium nutans	Caryophyllaceae	nodding chickweed
Holosteum umbellatum	Caryophyllaceae	jagged chickweed
Chenopodium leptophyllum	Chenopodiaceae	slimleaf goosefoot
Salsola kali	Chenopodiaceae	Russian thistle
Carex aperta	Cyperaceae	Columbia sedge
Carex douglasii	Cyperaceae	Douglas' sedge
Carex spp.	Cyperaceae	sedge species

Table I-9. Species Observed Downstream from 100-D Area, Boat Launch to River Mile 375. (sheet 2 of 2)

Species	Family	Common name
Eleocharis palustris	Cyperaceae	common spikerush
Equisetum arvense	Equisetaceae	common horsetail
Psoralea lanceolata	Fabaceae	dune scurfpea
Lupinus lepidus	Fabaceae	prairie lupine
Lupinus wyethii	Fabaceae	Wyeth's lupine
Erodium cicutarium	Geraniaceae	storksbill
Juncus balticus	Juncaceae	baltic rush
Asparagus officinalis	Liliaceae	asparagus
Sphaeralcea munroana	Malvaceae	globemallow
Marsilea vestita	Marsileaceae	clover fern
Agropyron caninum	Poaceae	slender wheatgrass
Agropyron dasytachyum	Poaceae	thickspike wheatgrass
Agropyron spicatum	Poaceae	bluebunch wheatgrass
Agrostis alba	Poaceae	redtop bentgrass
Bromus tectorum	Poaceae	cheatgrass
Elymus cinereus	Poaceae	giant wildrye
Oryzopsis hymenoides	Poaceae	indian ricegrass
Phalaris arundinacea	Poaceae	reed canarygrass
Poa bulbosa	Poaceae	bulbous bluegrass
Poa nevadensis	Poaceae	Nevada bluegrass
Poa pratensis	Poaceae	Kentucky bluegrass
Poa sandbergii	Poaceae	Sandberg's bluegrass
Sporobolus cryptandrus	Poaceae	sand dropseed
Microsteris gracilis	Polemoniaceae	pink gracilis
Potentilla rivalis	Rosaceae	brook cinquefoil
Rosa woodsii	Rosaceae	Wood's rose
Verbascum thapsus	Scrophulariaceae	common mullein
Collinsia parviflora	Scrophulariaceae	small blue-eyed Mary

Table I-10. Species Observed - River Mile 375 to 100-H Area.
(sheet 1 of 3)

Species	Family	Common name
Lomatium grayi	Apiaceae	Gray's desertparsley
Achillea millefolium	Asteraceae	yarrow
Artemisia campestris	Asteraceae	Pacific sage
Artemisia dracunculus	Asteraceae	tarragon
Artemisia ludoviciana	Asteraceae	prairie sage
Artemisia tridentata	Asteraceae	big sagebrush
Centaurea diffusa	Asteraceae	tumble knapweed
Centaurea repens	Asteraceae	Russian knapweed
Chaenactis douglasii	Asteraceae	hoary falseyarrow
Chrysothamnus nauseosus	Asteraceae	gray rabbitbrush
Chrysothamnus viscidiflorus	Asteraceae	green rabbitbrush
Cirsium arvense	Asteraceae	Canada thistle
Erigeron filifolius	Asteraceae	threadleaf fleabane
Erigeron poliospermus	Asteraceae	cushion fleabane
Gaillardia aristata	Asteraceae	blanket flower
Machaeranthera canescens	Asteraceae	hoary aster
Solidago occidentalis	Asteraceae	western goldenrod
Taraxacum officinale	Asteraceae	dandelion
Tragopogon dubius	Asteraceae	yellow salsify
Xanthium strumarium	Asteraceae	cocklebur
Descurainia pinnata	Brassicaceae	western tansymustard
Amsinckia lycopsoides	Boraginaceae	tarweed fiddleneck
Amsinckia tessellata	Boraginaceae	tessellate fiddleneck
Myosotis micrantha	Boraginaceae	blue forget-me-not
Draba verna	Brassicaceae	spring whitlowgrass
Lepidium densiflorum	Brassicaceae	prairie pepperweed
Lepidium perfoliatum	Brassicaceae	clasping pepperweed
Lesquerella douglasii	Brassicaceae	Columbia bladderpod
Rorippa columbiae	Brassicaceae	Columbia yellowcress
Rorippa curvisiliqua	Brassicaceae	western yellowcress

Table I-10. Species Observed - River Mile 375 to 100-H Area.
(sheet 2 of 3)

Species	Family	Common name
Rorippa obtusa	Brassicaceae	bluntleaf yellowcress
Sisymbrium altissimum	Brassicaceae	Jim Hill's tumblemustard
Cleome lutea	Capparidaceae	yellow bee-plant
Holosteum umbellatum	Caryophyllaceae	jagged chickweed
Sagina procumbens	Caryophyllaceae	procumbent pearlwort
Chenopodium album	Chenopodiaceae	lamb's quarters
Chenopodium leptophyllum	Chenopodiaceae	slimleaf goosefoot
Grayia spinosa	Chenopodiaceae	spiny hopsage
Salsola kali	Chenopodiaceae	Russian thistle
Juniperus scopulorum	Cupressaceae	Rocky Mountain juniper
Carex lanuginosa	Cyperaceae	wooly sedge
Carex douglasii	Cyperaceae	Douglas sedge
Cyperus aristatus	Cyperaceae	awned flatsedge
Equisetum arvense	Equisetaceae	common horsetail
Equisetum spp.	Equisetaceae	horsetail
Lupinus lepidus	Fabaceae	prairie lupine
Lupinus sericeus	Fabaceae	silky lupine
Lupinus wyethii	Fabaceae	Wyeth's lupine
Medicago lupulina	Fabaceae	black medick
Robinia psuedo-acacia	Fabaceae	black locust
Erodium cicutarium	Geraniaceae	storksbill
Ribes aureum	Grossulariaceae	golden current
Hypericum perforatum	Hypericaceae	St. Johnswort
Juncus tenuis	Juncaceae	slender rush
Allium cernuum	Liliaceae	nodding onion
Allium robinsonii	Liliaceae	Robinson's onion
Asparagus officinalis	Liliaceae	asparagus
Sphaeralcea munroana	Malvaceae	Munro's globemallow
Marsilea vestita	Marsileaceae	clover fern
Morus alba	Moraceae	Mulberry

Table I-10. Species Observed - River Mile 375 to 100-H Area.
(sheet 3 of 3)

Species	Family	Common name
Plantago patagonica	Plantaginaceae	indian wheat
Agropyron dasytachyum	Poaceae	thickspike wheatgrass
Agropyron spicatum	Poaceae	bluebunch wheatgrass
Agrostis alba	Poaceae	redtop bentgrass
Aristida longiseta	Poaceae	red three-awn
Bromus tectorum	Poaceae	cheatgrass
Elymus cinereus	Poaceae	giant wildrye
Hordeum glaucum	Poaceae	seagreen barley
Koeleria cristata	Poaceae	prairie Junegrass
Poa pratensis	Poaceae	Kentucky bluegrass
Poa sandbergii	Poaceae	Sandberg's bluegrass
Poa nevadensis	Poaceae	Nevada bluegrass
Phalaris arundinacea	Poaceae	reed canarygrass
Sporobolus cryptandrus	Poaceae	sand dropseed
Stipa comata	Poaceae	needle-and-thread
Collomia linearis	Polemoniaceae	narrowleaf collomia
Gilia minutiflora	Polemoniaceae	smallflower gilia
Microsteris gracilis	Polemoniaceae	pink microsteris
Polemonium micranthum	Polemoniaceae	annual Jacob's ladder
Eriogonum compositum	Polygonaceae	northern buckwheat
Polygonum convolvulus	Polygonaceae	climbing bindweed
Rumex crispus	Polygonaceae	curly dock
Ranunculus testiculatus	Ranunculaceae	bur buttercup
Potentilla rivalis	Rosaceae	brook cinquefoil
Prunus armeniaca	Rosaceae	apricot
Rosa woodsii	Rosaceae	Wood's rose
Salix spp.	Salicaceae	willow
Collinsia parviflora	Scrophulariaceae	small blue-eyed Mary
Verbascum thapsus	Scrophulariaceae	common mullein
Veronica anagallis-aquatica	Scrophulariaceae	water speedwell
Verbena bracteata	Verbenaceae	bracted verbena

Table I-11. Species Observed near 100-H Reactor. (sheet 1 of 2)

Species	Family	Common name
Cymopteris terebinthinus	Apiaceae	turpentine springparsley
Lomatium grayi	Apiaceae	Gray's desertparsley
Achillea millefolium	Asteraceae	yarrow
Artemisia campestris	Asteraceae	Pacific sage
Artemisia tridentata	Asteraceae	big sagebrush
Chrysothamnus nauseosus	Asteraceae	gray rabbitbrush
Cirsium arvense	Asteraceae	Canada thistle
Coreopsis atkinsoniana	Asteraceae	Columbia tickseed
Heterotheca villosa	Asteraceae	hairy golden-aster
Lactuca serriola	Asteraceae	prickly lettuce
Taraxacum officinale	Asteraceae	dandelion
Tragopogon dubius	Asteraceae	yellow salsify
Xanthium strumarium	Asteraceae	cocklebur
Descurainia pinnata	Brassicaceae	western tansymustard
Draba verna	Brassicaceae	spring whitlowgrass
Lepidium perfoliatum	Brassicaceae	clasping pepperweed
Rorippa islandica	Brassicaceae	marsh yellowcress
Sisymbrium altissimum	Brassicaceae	Jim Hill's tumblemustard
Dianthus armeria	Caryophyllaceae	grass pink
Holosteum umbellatum	Caryophyllaceae	jagged chickweed
Salsola kali	Chenopodiaceae	Russian thistle
Carex spp.	Cyperaceae	sedge
Equisetum spp.	Equisetaceae	horsetail
Melilotus alba	Fabaceae	white sweetclover
Ribes aureum	Grossulariaceae	golden currant
Juncus spp.	Juncaceae	baltic rush
Morus alba	Moraceae	white mulberry
Agropyron dasytachyum	Poaceae	thickspike wheatgrass
Agrostis alba	Poaceae	redtop bentgrass

Table I-11. Species Observed near 100-H Reactor. (sheet 2 of 2)

Species	Family	Common name
Bromus tectorum	Poaceae	cheatgrass
Phalaris arundinacea	Poaceae	reed canarygrass
Sporobolus cryptandrus	Poaceae	sand dropseed
Microsteris gracilis	Polemoniaceae	pink microsteris
Montia perfoliata	Portulacaceae	miner's lettuce
Rosa woodsii	Rosaceae	Wood's rose
Salix spp.	Salicaceae	willow
Verbascum thapsus	Scrophulariaceae	common mullein
Collinsia parviflora	Scrophulariaceae	small blue-eyed Mary
Mazus japonicus	Scrophulariaceae	Japanese mazus
Lycium halimifolium	Solanaceae	matrimony vine

spp. = species, more than one.

Table I-12. Species Observed in the Vicinity of 100-F Area. (sheet 1 of 3)

Species	Family	Common name
Cymopteris terebinthinus	Apiaceae	Turpentine springparsley
Lomatium grayi	Apiaceae	Gray's desertparsley
Apocynum cannabinum	Apocynaceae	Common dogbane
Asclepias speciosa	Asclepiadaceae	Showy milkweed
Achillea millefolium	Asteraceae	Yarrow
Ambrosia acanthicarpa	Asteraceae	bursage
Artemisia campestris	Asteraceae	Pacific sage
Artemisia lindleyana	Asteraceae	Columbia mugwort
Artemisia ludoviciana	Asteraceae	prairie sage
Artemisia tridentata	Asteraceae	big sagebrush
Aster hesperius	Asteraceae	western marsh aster
Centaurea diffusa	Asteraceae	diffuse knapweed
Centaurea repens	Asteraceae	Russian knapweed
Chrysothamnus nauseosus	Asteraceae	Gray rabbitbrush
Coreopsis atkinsoniana	Asteraceae	Columbia tickseed
Gaillardia aristata	Asteraceae	blanketflower
Machaeranthera canescens	Asteraceae	Hoary aster
Solidago graminifolia	Asteraceae	bushy goldenrod
Xanthium strumarium	Asteraceae	cocklebur
Amsinckia lycopsoides	Boraginaceae	Tarweed fiddleneck
Amsinckia tessellata	Boraginaceae	Tessellate fiddleneck
Myosotis micrantha	Boraginaceae	blue forget-me-not
Descurainia pinnata	Brassicaceae	Tansymustard
Draba verna	Brassicaceae	spring whitlowgrass
Lepidium perfoliatum	Brassicaceae	clasping pepperweed
Sisymbrium altissimum	Brassicaceae	Jim Hill mustard
Holosteum umbellatum	Caryophyllaceae	Jagged chickweed
Cerastium nutans	Caryophyllaceae	common chickweed
Salsola kali	Chenopodiaceae	Russian thistle

Table I-12. Species Observed in the Vicinity of 100-F Area. (sheet 2 of 3)

Species	Family	Common name
Convolvulus arvensis	Convolvulaceae	Field bindweed
Juniperus occidentalis	Cupressaceae	western juniper
Carex densa	Cyperaceae	dense sedge
Carex aperta	Cyperaceae	Columbia sedge
Carex microptera	Cyperaceae	smallwinged sedge
Cyperus erythrorhizos	Cyperaceae	red-awn flatsedge
Eleocharis palustris	Cyperaceae	common spikerush
Scirpus americanus	Cyperaceae	threesquare bulrush
Lupinus lepidus	Fabaceae	prairie lupine
Medicago lupulina	Fabaceae	black medick
Melilotus alba	Fabaceae	white sweetclover
Robinia psuedo-acacia	Fabaceae	Black locust
Swainsona salsula	Fabaceae	Salt rattlepod
Erodium cicutarium	Geraniaceae	Crane'sbill
Hypericum perforatum	Hypericaceae	St. Johnswort
Allium schoenoprasum	Liliaceae	chives
Sphaeralcea munroana	Malvaceae	Globemallow
Morus alba	Moraceae	Mulberry
Plantago lanceolata	Plantaginaceae	English plantain
Plantago patagonica	Plantaginaceae	Indian wheat
Platanus occidentalis	Platanaceae	Sycamore
Bromus tectorum	Poaceae	cheatgrass
Festuca arundinacea	Poaceae	Tall fescue
Sporobolus cryptandrus	Poaceae	Sand dropseed
Phalaris arundinacea	Poaceae	reed canarygrass
Poa bulbosa	Poaceae	bulbous bluegrass
Poa sandbergii	Poaceae	Sandberg's Bluegrass
Collomia linearis	Polemoniaceae	narrowleaf collomia
Eriogonum niveum	Polygonaceae	snow buckwheat

Table I-12. Species Observed in the Vicinity of 100-F Area. (sheet 3 of 3)

Species	Family	Common name
Montia perfoliata	Portulacaceae	miner's lettuce
Populus nigra	Salicaceae	Lombardy poplar
Salix exigua	Salicaceae	Coyote willow
Collinsia parviflora	Scrophulariaceae	small blue-eyed mary
Verbascum thapsus	Scrophulariaceae	wooly mullein
Ulmus pumila	Ulmaceae	Siberian elm
Verbena bracteata	Verbenaceae	Bracted verbena

APPENDIX J

SELECTED METALS CONCENTRATIONS IN ALL MEDIA

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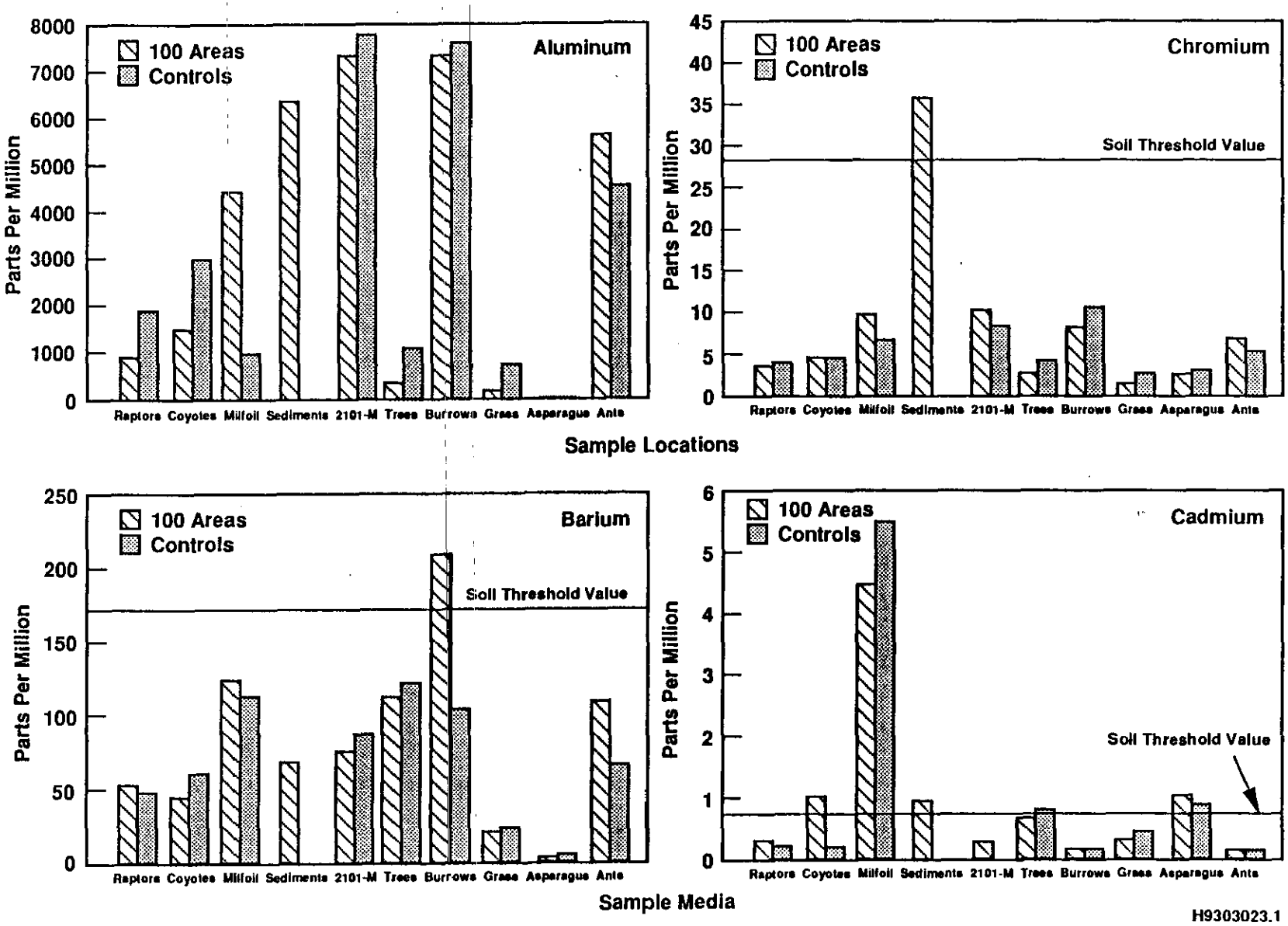

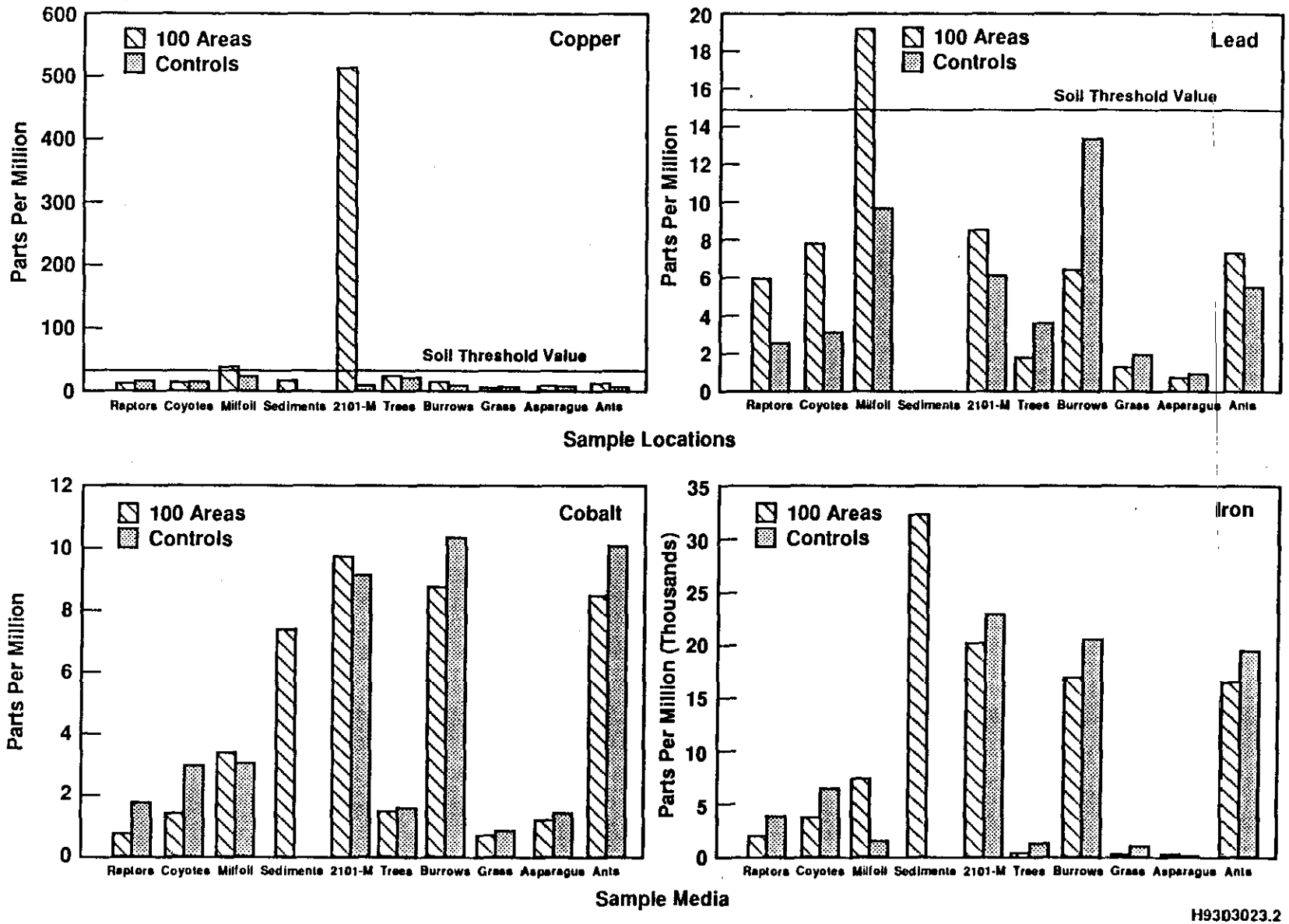

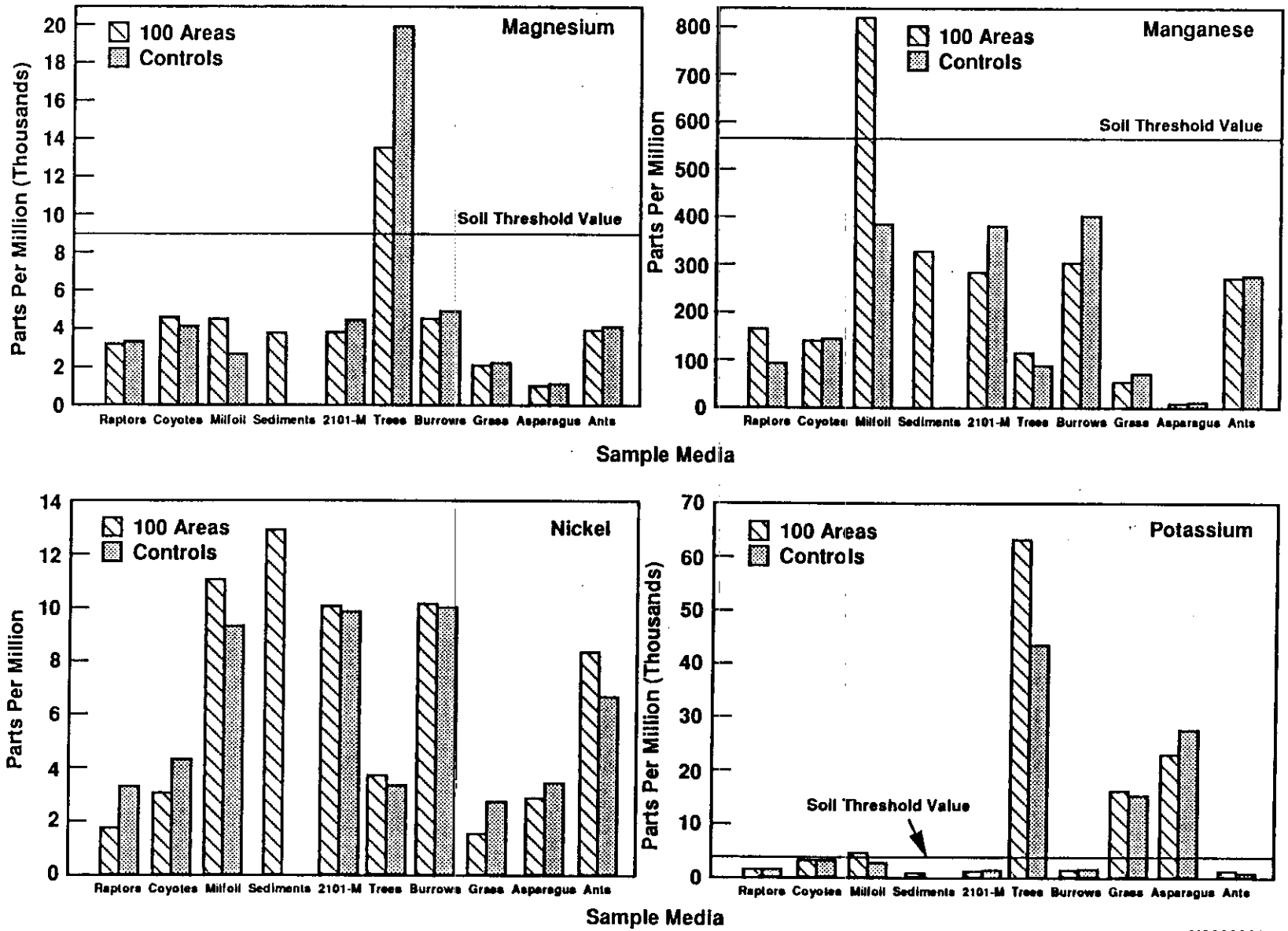
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2
4
6
8
10
12
14
16
18
20
Manganese
100 Areas
Controls
Soil Threshold Value
Parts Per Million
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100
200
300
400
500
600
700
800
Raptors Coyotes Milfoil Sediments 2101-M Trees Burrows Grass Asparagus Ants
Sample Media
Nickel
100 Areas
Controls
Parts Per Million
0
2
4
6
8
10
12
14
Potassium
100 Areas
Controls
Soil Threshold Value
Parts Per Million (Thousands)
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30
40
50
60
70
Raptors Coyotes Milfoil Sediments 2101-M Trees Burrows Grass Asparagus Ants
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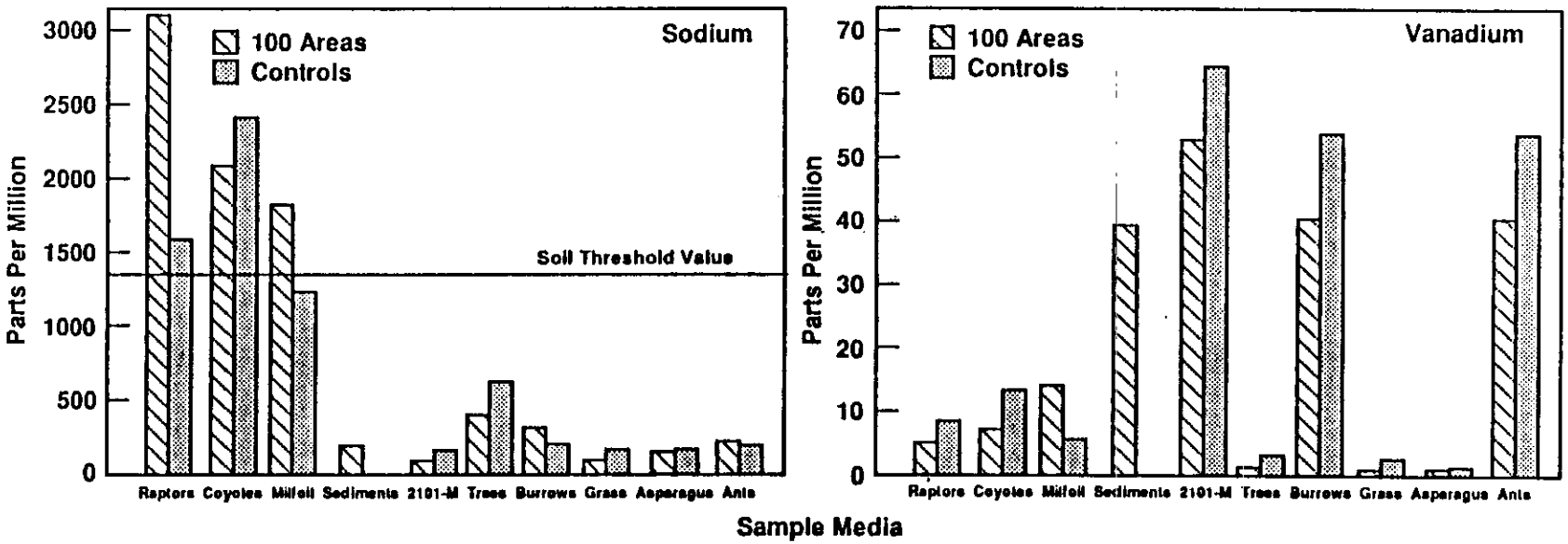
H9303023.3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100 Areas
Controls
Soil Threshold Value
Parts Per Million
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2000
1500
1000
500
0
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Vanadium
100 Areas
Controls
Parts Per Million
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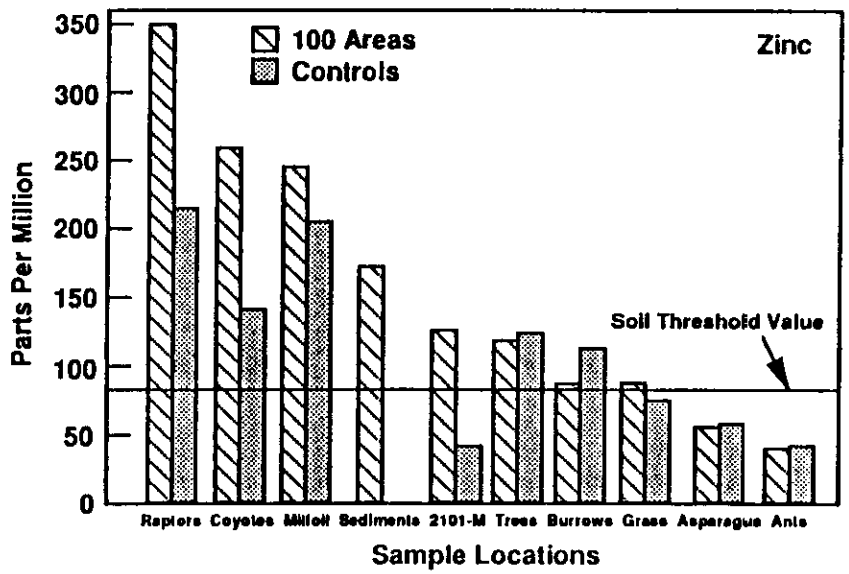
50
40
30
20
10
0
Raptors Coyotes Milfoil Sediments 2101-M Trees Burrows Grass Asparagus Ants
Sample Media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Soil Threshold Value
Parts Per Million
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100
50
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Raptors Coyotes Milfoil Sediments 2101-M Trees Burrows Grass Asparagus Ants
Sample Locations

H9303023.4

APPENDIX K

MARION OWNBEY HERBARIUM LETTERS

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Marion Ownbey Herbarium

Heald Hall G-9 Washington State University
Pullman, Washington 99164-4329 U.S.A.
(509) 335-3250

3 March 1993

Mike Sackschewsky
H4-14, Westinghouse Hanford Co.
P.O. Box 1970
Richland, WA 99352

Dear Mike,

At last I have been able to look at the *Carex* specimens you sent for identification and confirmation. A list of my determinations follows. Two species are of particular interest: *C. brevior* and *C. vulpinoidea*. Your *C. brevior* is the first WS record from Benton County, and from looking at the Northwest Flora one would think that's west of the known distribution for that species. However, WS has specimens from Yakima and Kittitas Counties, so this is one of those cases where this herbarium wasn't consulted in gathering distribution information for the Flora.

With respect to *C. vulpinoidea*, your material really emphasizes the importance of having completely mature perigynia. Of course immaturity is often a problem with sedges, but in species such as *C. vulpinoidea* it is especially critical. This is because of the pithy (sometimes called "spongy") material which is within the perigynium wall near the base of the perigynium. This tissue is what gives the perigynium its characteristic shape and appearance, and it develops late in the maturation process. Consequently, even at a stage when perigynia of most sedge species are recognizable, those of *C. vulpinoidea* look more like *C. dudleyi* perigynia. *Carex dudleyi* is one of the taxa submerged in *C. densa* in the Northwest Flora. *Carex dudleyi* resembles *C. vulpinoidea* in size and general shape of perigynia, but if *C. dudleyi* develops pithy tissue (which it occasionally does), that tissue is distributed differently in the perigynium and gives the mature perigynium a shape quite different from that of mature *C. vulpinoidea* perigynia. The immature perigynia on your *C. vulpinoidea* collections look much like perigynia of *C. dudleyi* and could key to *C. densa* in the Northwest Flora.[1] I wonder if this could be the source of the older records for "*C. densa*."

If your collections hadn't been so complete, including inflorescences of different ages from the same plants, the situation would have been more difficult to resolve.

---

[1] I should mention that there is a distinct difference in the *thickness* of the perigynium--0.4-0.7 mm in *C. vulpinoidea* and 0.7-1.1 mm in *C. dudleyi*--but this character is not included in existing treatments (except of course 1993 Jepson!).

207a *C. lanuginosa* Michaux
226a *C. athrostachya* Olney
227a *C. lenticularis* var. *lipocarpa* (Holm) L. Standley
240a ! *C. lanuginosa*
254a *C. athrostachya*
259a *C. brevior* (Dewey) Mackenzie
260b *C. vulpinoidea* Michaux
278a *C. vulpinoidea*
279a *C. athrostachya*
290a *C. vulpinoidea*
304a *C. vulpinoidea*
309a *C. vulpinoidea*

Did you receive the key excerpts I sent? By the way, if you're interested, the Jepson revision is out now.

I tried to phone you about these matters, and also because I've had an inquiry on how much it costs to put together a manual for plants of a particular area, similar to your book on Hanford plants. What this person needs to know is roughly the total it might cost, not including the field work, but the time to organize, put everything together, printing costs, etc. Would you be able to help with this? It doesn't have to be precise at all, just a general range of what one might expect.

Thank you for sending Vascular Plants of the Hanford site; it really came out nicely. Thank you too for the sedge specimens; they will be a very nice addition to the herbarium.

Sincerely yours,

Joy Mastrogiuseppe

Washington
State University

Department of Botany, Pullman, Washington 99164-4238 509-335-3066

4 March 1993

Mike Sackschewsky
H4-14, Westinghouse Hanford Co.
P.O. Box 1970
Richland, WA 99352

Dear Mike,

WS has only one Washington collection of *Carex densa*: Piper 6439, from Clark County, Vancouver, 2 June 1904. This is the record I was trying to remember. The Wahkiakum County specimen must be at UW. Evidently the species just barely extends up into Washington, though other records might well turn up.

Enclosed is a copy of Steppe by Step.

Sincerely yours,

Joy Mastrogiuseppe

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